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NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

PLAGUE IN NEW SOUTH WALES, 1905.

On a Fifth Outbreak of Plague at Sydney, 1905.

BY J. ASHBURTON THOMPSON, M.D., D.P.H., PRESIDENT,
Chief Medical Officer of Government.

On Outbreaks of Plague on the Clarence and Richmond Rivers, 1905.

BY R. J. MILLARD, M.B., CH.M. (SYD.), D.P.H. (CAMB.),
Assistant Medical Officer of Government, and Assistant Microbiologist,

On an Outbreak of Plague at Newcastle, 1905.

BY ROBERT DICK, M.B., CH.M. (SYD.), D.P.H. (CAMB.),
Medical Officer of Health, Hunter River Combined Districts.

Printed under No. 1 Report from Printing Committee, 12 July, 1906.

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REPORT OF THE BOARD OF HEALTH

ON A

FIFTH OUTBREAK OF PLAGUE AT SYDNEY, 1905.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of Government.

During the outbreak of 1904, a special effort was made to ascertain whether close connection between cases and plague-rats could not be established in every instance provided sufficient time were devoted to the search; and it was made with reference to two points. One was the difficulty, thought to be merely incidental, which had so often prevented demonstration of the presence of plague-rats on premises which had proved themselves to be infective, and the consequent incompleteness of the evidence which in general supported the view that rat-plague is a condition precedent of plague in man. The other was the desirability of examining more exactly into cases where it was thought, after due search, that neither rats nor signs of infestation by rats were present, which had appeared to have been the case in a very few instances; in which, nevertheless, presence of plague-rats in the immediate neighbourhood had been ascertained. However, while only 12 cases occurred in connection with 9 places of infection, the presence of plague-rats at each place was established, so that no opportunity of further examining the second point then offered.

2. As far as it went, that evidence was against the soundness of the observation which had been made, namely, that very rarely a house might prove to be a place of infection in absence of signs of infestation by rats; still, the point has been noted for further inquiry. But although in the year referred to the number of cases and of places was extremely small, it had been found that the labour involved in the constant watchfulness of all concerned, which turned out to be necessary to success, and of long quasi-detective enquiries, were too great to be continued by a staff whose daily avocations were multifarious and exacting. During the year now reported upon, therefore, no special attempt was made to run the plague-rat down in connection with every case, although the more salient points were as carefully recorded as usual.

3. The last case in 1904 had occurred on 10th September, and the last plague-rat had been identified on 3rd December. The continuous examination of rats, which began with the outbreak of 1901–2, having been maintained steadily since then, the first plague-rat in 1905 was identified 18th January. The date of attack in the first case of 1905 was 11th March, and in the last case of that year it was 12th July. The last plague-rat was identified on 5th December. The number of cases was 18, of which 5 were fatal; they were met with in connection with 18 dwellings (*see* cases E and G; G moved house after having been infected at E's dwelling.)

4. The period which it is necessary to review extended from 4th December, 1904, to 31st December, 1905, and may be divided as follows:—The precedent plague-free term lasted from 4th December, 1904, to 17th January, 1905; the epizootic period from 18th January to 5th December; and the subsequent plague-free period from 6th December to the end of the year. This latter period, it may be noted here, lasted only 49 days, the first plague-rat of 1906 having been taken at the Baltic Wharf, Darling Harbour, on 23rd January.

5. During the precedent plague-free period, 4th December to 17th January, the Intelligence Staff delivered 3,142 rats, 1,944 mice ; total, 5,086. All of them were examined in the laboratories, and none were infected with plague.

6. During the epizoötic period, 18th January to 5th December, the Intelligence Staff delivered 14,897 rats, 13,549 mice, total 28,446, all of which were examined, and among which plague was identified in 123 rats and 18 mice, total 141. Additionally, 3 other animals were referred for examination, namely, 1 domestic cat, 1 native cat (*Dasyurus viverinus*, Shaw), and 1 kangaroo-rat (*Æpyprymnus rufescens*, Gray). All were found to be free from infection with plague. This period commenced with discovery of plague-infected specimens of *M. rattus* at the North Coast Steamship Company's Wharf at Darling Harbour, and at a later date of *M. decumanus*. They had, perhaps, been reimported from one of the infected spots on the Northern Rivers to which the infection had probably been communicated from Sydney towards the end of the preceding year, or (in the case of one town) from another infected State (*see* Report on Plague on the Northern Rivers, *infra*). The meaning attached in this series of reports to the word "identified" should be borne in mind. Many other rats which were reasonably believed to have died of plague, but which were too advanced in putrefaction for bacteriological examination, were brought in or observed ; still, were these added, the total thought to have died of plague would still bear but a small proportion to the total taken. It is considered that a proportion (which may be considerable) of the carcases of rats which have died of plague never come to light.

7. During the subsequent plague-free period, which extended from 6th December to the end of the year, the Intelligence Staff brought in 956 rats, 552 mice, total, 1,508, all of which were examined and found to be plague-free.

8. The number of rats destroyed during the whole year—that is, from 1st January to 31st December—was 52,027 rats, 39,092 mice ; total, 91,119. A reward for the carcases of rats and mice was again offered to the public, and was paid from 1st April to 31st October. The numbers paid for were 34,963 rats, 24,261 mice ; total, 59,224. None of them were examined. The number brought in by the Intelligence Staff during the whole year was—rats, 17,064 ; mice, 14,831 ; total, 31,895.

9. The species of rodents brought in by the Intelligence Staff during the whole year, and their respective numbers, were as follows :—*M. decumanus*, 11,383 ; *M. rattus*, 5,681 ; *M. musculus*, 14,831. The percentages of each to the total were :—*M. decumanus*, 35·68 ; *M. rattus*, 17·80 ; *M. musculus*, 46·49.

10. During the epizootic period alone, the numbers of each species in which plague was identified were—*M. decumanus*, 78 ; *M. rattus*, 45 ; and *M. musculus*, 18 ; and the percentages of infected specimens to the total of each species examined during this period were respectively ·79, ·88, and ·13, which were practically the same as the proportions noted in former years.

11. The following abstracts exhibit the salient features and circumstances of each case :—

Case A.

H.E., m., æt. 22, single, labourer ; no former attack ; not inoculated ; no communication with any previous case. Residence, 47, Gipps-street, Balmain ; employment, McDonald's produce store, Harbour-street, Darling Harbour ; last at work, 11th March. Attack, 11th March, sudden, about 7 a.m. ; first sign, pain in bubo of left femoral region ; the swelling must have begun previously. Notified by Dr. Shirlow, 11·30 a.m., 16th March ; visited (F.T.) 12·30 ; admitted to Coast Hospital, 6 p.m. ; discharged, 20th April ; duration of illness, 40 days. Material from bubo, 16th March ; films, indefinite ; cultures, positive ; inoculation (guinea-pig), positive. Lesions of drainage-area, one or two small scabs, and flea-bites.

Rats.—At residence, none ; at employment, 4 living, 6 dead, rats ; 4 living, 1 dead, mice ; plague not identified.

Connected Cases.—None.

Case B.

C.L., m., æt. 47, single, caretaker ; no former attack ; not inoculated ; no communication with the previous case. Residence (concealed by patient, but traced to), Empire Club, 219, Castlereagh-street ; last there, not known. Attack, 2nd April, evening ; admitted to Sydney Hospital, 3rd April, 10 p.m ; notified thence by Dr. Corbin, 5th April, 9·30 a.m. ; visited (R.J.M.), 10 a.m. ; admitted to Coast Hospital, 2 p.m. ; discharged, 13th May ; duration of illness, 41 days. Bubo, none present 3rd April ; present, 4th morning ; left femoral region ; material from bubo, 5th April, films, positive. Lesions of drainage area, none.

Rats.—Residence and place of employment were the same ; no rats could be found. (Before the place—which was a low gambling club—could be traced, the proprietors had taken great pains to cleanse it and place it in good order.)

Connected Cases.—See J.A., a rat-catcher, with whom C.L. was friendly.

Case C.

Case C.

E.O'R., f., æt. 44, widow, laundress. No former attack; not inoculated; no communication with any previous case. Residence, 40, Bathurst-street, city; employment, Tyne Laundry, Manly, a suburb 7 miles from residence, reached by water; last employed, 4th April. Attack, felt ill 3rd April, but went to work; went also on 4th, but could hardly work; 5th, was too ill to get up; on 6th a slightly enlarged left femoral gland was present; smears positive; no lesions of drainage area. Notified by Dr. G. H. Taylor, 6th April, 2·30 p.m.; visited (R.J.M.), 3 p.m.; admitted Coast Hospital, 6 p.m.; discharged to the general division of the hospital, 19th May; duration of illness, 46 days.

Rats.—One plague-infected mouse at residence, which was next door to a 12-stall stable, where dead rats and mice were found.

Connected cases.—*See* Case G.

Case D.

A.P., m., æt. 22, single, wharf-labourer. No former attack; not inoculated; no communication with any previous case. Residence, 8, Starling-street, Rozelle; employment, various wharfs on Darling Harbour; last there (Grafton Wharf), 24th March; attack at 10 a.m. on that date, but finished his work; not notified as plague; admitted to Coast Hospital in ordinary course, 28th March, 7·30 p.m.; died, 20th April; duration, 27 days. Cultures and inoculation made from a boil just below a carbuncle on left upper arm, positive; there were many other boils elsewhere. Plague was not suspected on admission in this case, which seemed to be one of septic infection, till a large glandular swelling made appearance on right side of neck 9th day of illness, and a smaller swelling on left side; but material taken from the former yielded only streptococci and staphylococci, and a guinea-pig inoculated with it remained well; afterwards, the skin manifestation, which had first appeared 30th March, was examined, with the positive result mentioned.

Rats.—At residence, none; slight traces of mice. At Grafton Wharf no plague rats were found; but patient had not been exclusively employed there, and his history could not be completely ascertained. (*See* Plan.)

Connected cases.—None.

Case E.

J.A., m., æt. 48, single, Departmental rat-catcher. Former attack 13th July, 1900; was inoculated (Haffkine) 10th Aug., 1903; conveyed Case B to Sydney Hospital as friend, 3rd April. Residence, 133, Dowling-street, Woolloomooloo; employment, various infected places; has brought in several plague rats; last employed, night of 7th April. Admitted Coast Hospital, 8th April, discharged 16th May, duration 40 days. Attacked 6th April, slight pain left groin; 7th morning felt unwell and was examined (R.J.M.) while delivering his rats; T. 100, otherwise normal, but left femoral gland slightly enlarged and tender; a very definite track of lymphangitis was traced back to a small suppurating sore on lower third of the leg, said to be of two or three days standing. Was again examined 8th April, morning, T. 102·4, P. 114; the sore then presented a small vesicle, in which no *B. pestis* were found by direct examination. Cultures and inoculations made with it yielded positive results, as also did material from the bubo, both taken 8th April.

Rats.—During the twelve days, 27th March to 7th April, patient had handed in plague rats or mice on nine of them; the last, a mouse, on 6th April; the last rat on 3rd April.

Connected cases.—Was associated with Case B at night, 3rd April.

Case F.

A.L., m., æt. 11. No former attack; not inoculated; no communication with any previous case. Residence, 253, Kent-street, City; attends Fort-street State School; also sells newspapers, chiefly on local steamboats, and thus frequents wharfs at Darling Harbour. Notified by Dr. G. A. Marshall, 10th April, 3 p.m.; visited (R. J. M.) 3·45; admitted to Coast Hospital 9 p.m.; died 23rd April; duration 14 days. Attack, 9th April, 3 p.m.; first symptoms, headache and pain in left femoral region, where bubo material taken 10th, culture positive. Lesion of drainage-area; a hyperæmic spot on left patella.

Rats.—At residence none found; six rat-holes; some rooms infested with bugs and fleas.

Connected cases.—None.

Case G.

J. O'R., m., æt. 15, street-cleaner, employed by City Council. No former attack; not inoculated; son of E. O'R., Case C, with whom he lived till her admission to hospital. Residence, 14, Steam Mill street, Darling Harbour; employment, in streets; last employed about 1st April. Notified by Dr. Corbin from Sydney Hospital on 13th April, where he had been admitted same day; visited (R.J.M.) 14th, 9·30 a.m.,; not removed; discharged 25th April; duration about 17 days. Attack: about 1st April, while living in Bathurst-street, where his mother was attacked 3rd April; had severe ear-ache, which was soon relieved, but deafness remained; on 6th was first employed as street cleaner; on 8th noticed pain in right side of neck; on 13th was admitted to Sydney Hospital, with T. 101, P. 100, R. 24, but all were normal next morning. On examination, he did not seem ill; in posterior triangle of neck, right side, were several slightly enlarged and tender glands, the largest being the size of a small marble and situated under the trapezius. Material taken from it showed nothing in film; culture of it on agar yielded an involuted bacillus which did not morphologically resemble *B. pestis*; an agar subculture from this yielded no growth, but a serum subculture yielded a fairly copious growth identical with that from which it was made. A guinea-pig inoculated from the culture died on the 5th day, and exhibited typical lesions of plague; films made from internal organs showed enormous numbers of *B. pestis*, and the latter was recovered from them by cultivation. This result was attained on 25th April; on inquiry at the hospital it was found the patient had been discharged well that morning.

Rats.—At residence (40, Bathurst-street.) *See* Case C.

Connected cases.—*See* Case C.

CASE H.

S.H., m., æt. 24, single, wood-worker. No former attack; not inoculated; no communication with any previous case. Residence, 8, Fredburt-street, Leichhardt; employment, Saxton and Binns' timber-yard, Blackwattle Bay, City; last employed, 15th April. Notified by Dr. Shirlow, 15th April, 8 p.m.; visited (R.J.M.), 20th April, 9·30 a.m.; admitted to Coast Hospital 5 p.m.; discharged 16th June; duration, 57 days. Attack: 16th April, shivering, headache, and general pains after having gone to sleep aroused him; 17th, early morning found a painful swelling in right groin; vomited occasionally 17th, 18th, and 19th; on latter date at 6 p.m. had a convulsion. Bubo, right femoral; material taken 20th, films and cultures positive. Lesions within drainage-area, none.

Rats.—At residence, no signs; at employment it was reported by the proprietors that there had been many, but that they had rather suddenly disappeared about a week ago. Two rat-catchers detailed to these premises trapped but a single rat in the course of a week.

Connected Cases.—None.

CASE I.

L.K., m., æt. 29, single, carter. Not inoculated; no former attack; no communication with any previous case. Residence, 21, Rose-street, Darlington; employment, 39, Boundary-street, Redfern, a produce store kept by his brother; frequently visited Darling Harbour wharves, and fetched corn or chaff from Union Wharf on 13th, North Coast on 14th, and Union on 17th. Notified by Dr. Gordon Craig, 20th April, 3 p.m.; visited (W.G.A.), 4 p.m.; admitted to Coast Hospital, 21st April; discharged, 19th May; duration, 32 days. Attack: 17th April, noon; fever, headache, and a bad cough. On examination, a small right femoral bubo (very tender), and two inguinal glands slightly enlarged (hardly tender); films and cultures from femoral and from an inguinal gland, both positive. Lesion of drainage area: a small cicatrix on the sole of the right foot left after extraction of a thorn by patient on 17th April.

Rats.—At residence, no signs; at employment, signs of recent infestation; one live rat caught, which was plague-free. The last preceding plague-rat at North Coast Company's wharf had been taken 11th March.

Connected Cases.—*See* Case K.

CASE K.

T.K., m., æt. 40, married, produce dealer. Not inoculated; no former attack; connected with preceding Case I. Residence and employment as in Case I, but was employed at the store. When L.K. fell ill, he took up his work on 17th April, and collected produce from Union Wharf 18th, and from North Coast Wharf 19th April. Notified by Dr. Gordon Craig, 23rd April, 2 p.m.; visited (W.G.A.), 3 p.m.; admitted to Coast Hospital, 23rd April; discharged, 19th May; duration, 30 days. Attack: felt tired on rising 21st April, and had stiffness in left groin; towards night became feverish. Bubo in left femoral chain, size of a pigeon's egg; tender, not painful; lesions of drainage area, none; on 25th, films made with material from bubo, negative; cultures positive.

Rats and Connected Case.—*See* Case I.

CASE L.

R.H., m., æt. 18, single, labourer. Not inoculated; no former attack; not connected with any other case. Residence, 69, Derwent-street, Glebe; employment, a wood and coal yard at 86, Abercrombie-street, City, making up orders for despatch; does not leave these premises during work. Notified by Dr. R. Bohrsmann, 24th April, 7·20 p.m.; visited (R.J.M.), 25th, 9·30 a.m.; admitted to Coast Hospital, 3 p.m.; discharged, 29th May; duration, 36 days. Attack sudden, 23rd April, 4·30 p.m.; severe pain in back and right groin; no sleep at night; slightly delirious. On examination large right femoral bubo which fills Scarpa's triangle, in which three or four glands can be distinguished, extremely tender; some deep tenderness above Poupart's ligament; lesions of drainage area, a small round hyperæmic patch on anterior aspect of thigh just below the anterior superior iliac spine. Material from bubo, taken 25th April, films and cultures positive.

Rats.—At residence, signs of infestation, 1 nest, 1 live rat, 1 putrid carcase; a stable, no rats; 1 putrid carcase in yard of No. 71; no rats at produce store near by, where feed for horse purchased. At Abercrombie-street, no sign of infestation.

Connected Cases.—None.

CASE M.

J.C., m., æt. 28, married, ship-painter. Not inoculated; no former attack; no communication with any preceding case. Residence, Davidson-street, Balmain; employment, Adelaide S.S. Co.'s works, Nicholson-street, Balmain. Last employed, 25th April, cleaning and painting s.s. "Ouraki." Notified by Dr. Carruthers, 26th April, 8·30 p.m.; visited (R.J.M.), 27th, 10 a.m.; admitted to Coast Hospital, 5 p.m.; discharged, 31st May; duration, 36 days. Attack: 24th April, headache during the evening; 25th, felt ill on rising; went to work; gave up after two hours; at mid-day, pain in left axilla began; delirious at night; 26th, pain in axilla increased and was severe, headache slight, no vomiting; 27th, on examination, general fulness of axilla, an enlarged and very tender gland beneath border of pectoralis major, and another which could be just made out behind it; clear lymph withdrawn by needle; films and cultures negative; further material taken 29th April; cultures positive; lesions within drainage area, none.

Rats.—At residence, no signs; at employment, the works in general presented no signs of infestation, but there was plenty of harbourage for rats among lumber, &c. Quiet inquiry among the employees elicited information that during cleansing and painting of the "Ouraki's" forepeak, where the patient was employed, about 24 dead rats had been collected. The Departmental rat-catcher turned out 10 more carcases, and trapped 2 live rats; the latter were plague-free, the former too putrid for bacteriological examination; and ultimately no plague-rats were identified, either from this vessel or from the works (12 live rats altogether were taken from the vessel and examined).

Connected Cases.—*See* Case N.

CASE N.

CASE N.

F.L., m., æt. 44, married, labourer. Not inoculated; no previous attack; employed on same ship as J.C., Case M. Residence, 19, Theodora-street, Balmain; employment, Adelaide S.S. Co.'s works, Nicholson-street, Balmain. Last employed, 4th May, on the s.s. "Innamincka"; 3rd May, s.s. "Innamincka" and "Adelaide"; 2nd May, on s.s. "Mintaro" and the wharf; 1st May, in bunkers of the "Ouraki"; 29th April, in limbers and holds; 28th to 25th April, on deck of forepeak. Notified by Dr. Carruthers, 5th May, 9 a.m.; visited (R.J.M.), 10·15 a.m.; admitted to Coast Hospital, 4 p.m.; discharged 31st May; duration, 28 days. Attack: 4th May, felt heavy on waking; went to work; pain in right groin at 10 a.m.; ceased work at 2·30, having apparently become extremely weak, since his fellow-workmen gave him whisky before he could leave for home; at night, rigors, feverish, bad headache, light-headed; 5th, on examination, three oblique inguinal glands enlarged, very tender, some periadenitic effusion; films and cultures positive; lesions within drainage area, none.

Rats.—At residence, no signs; at employment, *see* Case M.

Connected Cases.—*See* Case M.

CASE O.

E.O., f., æt. 40, married, dressmaker; last employed, 10th May. Not inoculated; no former attack; not connected with any previous case. Residence, 101, Moncur-street, Woollahra; employment, 38, Elizabeth street, City. Notified by Dr. Johnson; visited (T.W.S.), 13th May, noon; admitted to Coast Hospital, 13th May; discharged, 9th June; duration, 38 days. Attack, 2nd May, 7·30 p.m.; pain in right groin, shivering, headache, but swelling in groin first noticed by patient, 5th; the same symptoms continued, but she supervised her shop till 10th, when she was obliged to give up. On examination exhibited a tender inguinal gland the size of an almond; lesion of drainage area, none; films and cultures made with material taken 13th May, both positive.

Rats.—At residence, signs of recent infestation in rat-holes and fresh droppings, one carcase found, too putrid for examination; at employment, no signs. The fence at bottom of patient's yard is also the back fence of Lynch's dairy premises, on which many plague-rats were found.

Connected Cases.—None.

CASE P.

B. de G., m., æt. 34, married, furniture dealer. Not inoculated; no former attack; no communication with any other case. Residence, 49, Underwood-street, Paddington; employment, 121½, Castlereagh street, City; last employed, 13th May. Notified by Dr. Walton Smith, 15th May; visited (T.W.S.), 2 p.m.; admitted to Coast Hospital, 7 p.m.; discharged, 13th June; duration, 31 days. Patient was extremely deaf, and his memory apparently not good; but the following account was got with assistance of his brother, and of the Medical Officer of Health, Newcastle:—For some days prior to 5th May he had been employed at a furniture shop, 199–205, Hunter-street, Newcastle, and on that day was watching cleansing operations necessitated by discovery of a large number of plague-rats on those premises; the same night he returned to Sydney. On 9th May he attended a lodge meeting, and during the evening he became so ill he was obliged to go home—headache and extreme general malaise. He was a little better 10th, and went about his business, though feeling ill; on 13th, the headache and general malaise returned somewhat severely during the evening; 14th, had much nausea, vomited once, and during the day felt pain in the left groin; on examination, 15th, a left femoral gland was found slightly enlarged and rather tender; lesions of drainage area, none; films and cultures, positive.

Rats.—At residence, few traces, none present, no carcases; search of neighbourhood failed to raise suspicion of plague; the house was a mile distant from Moncur-street. At employment, few traces. (*See* Case O.)

Connected Cases.—None.

CASE Q.

P.F., m., æt. 20, single, grocer. Not inoculated; no former attack; no communication with any other case. Residence, 136, Oxford-street, Paddington; employment, 277, Sussex-street, Darling Harbour; last employed, 20th May. Notified by Medical Superintendent (Dr. Corbin), Sydney Hospital, 23rd May, 11 a.m.; visited (F.T.), 11·10; admitted to Coast Hospital, 2 p.m.; died, 23rd May, 10 p.m.; duration, 2 days. Attack, 21st May, 3·30 p.m., shivering and pain in left groin. On 20th May (Saturday) was kicked at football in the left groin, and ceased play for five minutes; 21st, no pain in groin on waking, but in afternoon the pain suddenly returned, accompanied by a violent shivering fit; he vomited; was delirious at night; became unconscious, and remembered nothing till he found himself at Sydney Hospital 23rd morning, when he recovered his senses. On examination, swelling of glands of left femoral chain, considerable periadenitic effusion, but slightly painful, extremely tender; lesions of drainage area, small recent abrasion on shin received 20th, no other; films and cultures, positive.

Rats.—At residence, no signs; at employment, evident signs of infestation; on turning over the stock, carcases of 7 rats and 18 mice were found either dried up or advanced in putrefaction. A plague-rat had been got at No. 271 (next door but two) on 4th May.

Connected Cases.—None.

CASE R.

R.D.A., f., æt. 8½. Residence, 16, Burton-street, Camperdown; attended school (St. John's) last, 22nd June; not inoculated; no former attack; no communication with any other case. Reported after death by Dr. Buchanan, Pathologist, Prince Alfred Hospital, 10th July. Cultures then submitted by him made from heart's blood were found to be positive; subcultures from them yielded no growth; guinea-pig inoculated with them died of plague. He also referred cultures from heart's blood and spleen of a guinea-pig stated to have been inoculated by him with a broth culture made from patient's spleen, which were found to be positive; subcultures made from them were positive, and guinea-pig inoculated with the spleen culture died of plague. Attack: was quite well 26th June; 27th woke with headache, vomited after drinking; at 6 p.m. delirium was observed, and soon after became stuporous; had two convulsive attacks in the course of the evening; at 9 p.m. was admitted to Prince Alfred Hospital, T. 105; died 11·15 p.m. During the morning her mother said she noticed a lump behind her left ear, and supposed mumps was beginning.

Post-mortem examination by Dr. Buchanan. *P.-m.* made 28th June, twelve hours after death. "Rigidity and lividity, well marked. *Abdomen:* No free fluid; no evidence of peritonitis. No petechial haemorrhages under visceral peritoneum. *Spleen:* Slightly enlarged (7 oz.) and very slightly softer than normal. *Kidneys:* Congested; otherwise healthy. *Liver:* Normal. *Alimentary canal:* There were several patches of congestion in the wall of the stomach. The Peyer's patches in the lower 2 feet of the ileum were enlarged, slightly congested, very granular looking on the surface, as if evidencing early ulceration. There was only very slight congestion around these patches. The solitary follicles of the large intestine, especially of the sigmoid, were greatly enlarged, and stood out as shot-like elevations. The mesenteric glands in the lower part of the mesentery were also enlarged. *Lungs:* Congested at bases. *Heart:* No petechial hæmorrhages in pericardium. No sign of peri- or endo- carditis. *Brain:* The superficial cortical vessels were much engorged, and the brain tissue was markedly hyperæmic. No gross lesion was to be found in the brain. Tissue specimens were preserved from the bowel, and cultures on blood serum and agar taken from the spleen and heart." The swelling behind the ear referred to by the child's mother either did not exist, or was overlooked. "True plague bacilli" were seen in films made from heart's blood and from the spleen at the date of *post-mortem* examination.

Rats.—It is to be regretted that Dr. Buchanan's failure to appreciate the public importance of early notification made it impossible to begin the epidemiological enquiry (and cleansing operations) until twelve days after death. Such a delay is unprecedented in our experience, but fortunately it did not actually involve serious consequences. At dwelling, no traces; parents denied presence of rats, dead or alive. In neighbourhood, which was well searched, no plague-rats, nothing suspicious. Till just before date of attack, patient's father had kept a horse, and had got feed from Maguire's produce store, about half a mile away, where in 1902 many plague-rats had been taken, and one case occurred (Report 1902, pars. 138–9); nothing could be found there. The child's mother and an elder sister said she had not to their knowledge been away from the neighbourhood of the house since ceasing to attend her school (22nd June); but a playmate said she visited a fruit shop with her, 24th June; this place was very thoroughly searched without any result. In short, the source of infection remained undetected after all enquiry had been made. Plague-rats continued to be found until 3rd December in the city, but at six places (about 2 miles away) only, of which five were wharves on Darling Harbour, the sixth a shop at some little distance from them. Nor had any been found at all near to patient's residence prior to the date of attack since 1902, or three years before.

Connected Cases.—None. The household consisted of the parents and eight children.

CASE S.

W.C., m., æt. 47, married, rat-catcher of the City Council's staff. Not inoculated; no former attack; no communication with any other case. Residence, 33, Ivy-street, Darlington; employment, various places, infected and other; last employed, 12th July. Notified by Dr. R. Bohrsmann, 14th July, 11·30 a.m.; visited (R.J.M.), 12·15; admitted to Coast Hospital, 5 p.m.; died, 12th August; duration, 31 days. Attack: 12th July, had gone to bed in his usual health; on rising felt very cold, and vomited before breakfast; delivered his rats at the laboratory; went home to bed, where he remained; 13th, vomited occasionally during the day; 14th, a lump appeared in the left groin. On examination presented a bubo in the left femoral region; no lesion of drainage area seen (skin very dirty); films and cultures, positive.

Rats.—At residence, no signs. This man, as a member of the rat-staff belonging to the L.A. for the city, had been employed on buildings in the neighbourhood of the wharves, but not on the wharves; he had delivered rats regularly, but no identified plague-rat had been brought in by anyone for 14 days before his attack, nor afterwards from any place at which he had recently trapped rats.

Connected Cases.—None.

12. In 16 of these cases buboes were exhibited; Cases D (d)* and R (d) had none. The buboes were femoral and solitary in the 11 Cases A, B, C, E, F (d), H, K, L, P, Q (d), and S (d). Solitary inguinal buboes occurred in Cases N and O. In Case I a bubo in a femoral gland was attended with later, and hardly painful, swelling of an inguinal gland. The bubo was axillary and solitary in Case M; and several glands were slightly enlarged and rather tender in the posterior triangle of the neck in Case G.

13. Pain in the gland, which became the seat of bubo, was the first sign of illness in Cases A and E; and it was among the first signs in the 5 Cases F (d), I, K, L, Q (d), in which it occurred simultaneously with the initial rigor, &c. Pain, prior to swelling, or the swelling itself, was first observed at hours after attack in

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* (d)—Died.

the 7 Cases N, M, H, S (d), C, O, and P as follows :—4 hours, 6 hours, 1 day, 2 days, 3 days, 3 days, and 5 days (doubtful). In Cases B and G the time could not be fixed, while D (d) and R (d) had no bubo.

14. Lesions within the drainage area of the gland which was the seat of bubo were sought for. The 3 Cases D (d), G, and R (d) were not notified as plague, and were either not examined or not within the requisite time. In the 9 Cases B, C, H, K, M, N, O, P, S (d) there was no lesion. In the 6 Cases A, E, F (d), I, L, Q (d) some lesion was detected, as shown below :—

Case.	Bubo.	Lesion.
A	Femoral	Small scabs and flea-bites.
E	„	A small suppurating sore ; lymphangitis.
F (d)	„	Hyperæmic spot on patella.
I	Femoral and Inguinal	Small recent cicatrix on sole of foot.
L	„	Small, round, hyperæmic patch.
Q (d)	„	Abrasion of shin, received the day before attack.

15. The associated cases were 4 pairs—namely, B and E, C and G, I and K, and M and N. *Cases B and E:* B was friendly with E, who was a staff rat-catcher, and was said to have sometimes accompanied E when he was about his work ; this was not very clearly made out, but if he did so he certainly ran into danger. B was attacked 2nd of April ; 24 hours later E took him to hospital. The first sign of E's attack occurred at some time on 6th April ; he had collected plague-rats within the usual incubation period. *Cases C and G:* Mother and son, who were living in the same house when C was attacked, 3rd April ; a plague-mouse was found in the house after notification of her case, and several dead rats were found at a stable next door. The date of G's attack cannot be fixed, but it may have been, and probably was, about the same time as E's ; his case was mild, and, after his mother had gone to hospital he removed to another house near by, to which no particular suspicion attached. *Cases I and K:* Two brothers, who kept a produce store in a suburb, where they lived together ; there was nothing to suggest infection of the house, but produce was carried there from the wharves. I's business was to visit certain Darling Harbour wharves to fetch supplies of produce ; when he fell ill K took up this part of the business, to which he had not usually attended. I was attacked 17th April, and was removed to hospital 21st April ; K was attacked 21st April. Both cases were bubonic and mild. The wharves visited were dangerous places at the time, and K would seem to have become infected only after having taken up I's business of carting from the wharves. *Cases M and N:* These men associated only at their place of employment, and, clearly enough, were infected on board the ship they were both engaged to repaint.

16. The Local Authority for the suburban borough of Woollahra detected dead rats at a tumble-down stone and wood cottage, No. 4 Morell-street ; 14 carcases were removed from it, of which 8 were ascertained in the laboratories to be plague-infected. Burrows ran to the premises next door, which were occupied by a cow-keeper ; his feed-store, which was a wood and iron structure, had an earthen floor in part covered with tarred metal, and contained a good deal of feed in bags and bales. On moving this it was found that the floor was undermined by rat-burrows in every direction, and that a disused drain opened through it. Here 32 carcases were collected, 21 of which were plague-infected. Single plague rats were afterwards collected from each of 2 premises in John-street and Peaker-lane, at a considerable distance from Morell-street. The Local Authority detected the mortality in the course of watch it was keeping on the rats within its district ; as soon as plague was identified, the Department assumed supervision, and carried out the necessary cleansing work with assistance of labour supplied by the Local Authority under direction of its Sanitary Inspector (Mr. Wormall, Cert. R. San. Inst.). Produce had been received at the dairy shortly before from infected wharves at Darling Harbour. It will be observed, first that the infection was conveyed to this distant suburb *per saltum* in connection with the transport of produce (as usual) ; and secondly, that the Local Authority had not enforced the By-laws made by it for Better Prevention of the Spread of Plague by Rats (*see* Report 1903, Appendix A), in that the feed-store at the dairy had not a floor of

concrete or of other approved material impervious to rats. The attention of the Local Authority was drawn to the probability that had it had such a floor there could have been no such rat-warren as existed, and although the disease might have been imported, it would have had very small opportunity of spreading. Fortunately the outbreak was soon brought under control, and the only result as regards man was infection of Case O, the backyard of whose house was separated from the cow-keeper's only by a dilapidated fence.

17. Plague was identified in rats or mice taken at 28 premises, which may be classified as follows :—Darling Harbour wharves (and 1 bond, 1 coasting steamer alongside), 15 ; produce stores (1 cow-keeper), 6 ; private houses, 4 (1 close to infected wharves and next to an infected stable, 3 at Woollahra) ; 1 hotel, 1 general importer, 1 tailor.

18. The methods of prevention continued the same as have been previously described.

19. The forms hitherto in use by Staff Medical Officers, by the Medical Staff at the Coast Hospital, and by Staff Sanitary Inspectors, are now printed in Appendix A.

J. ASHBURTON THOMPSON.

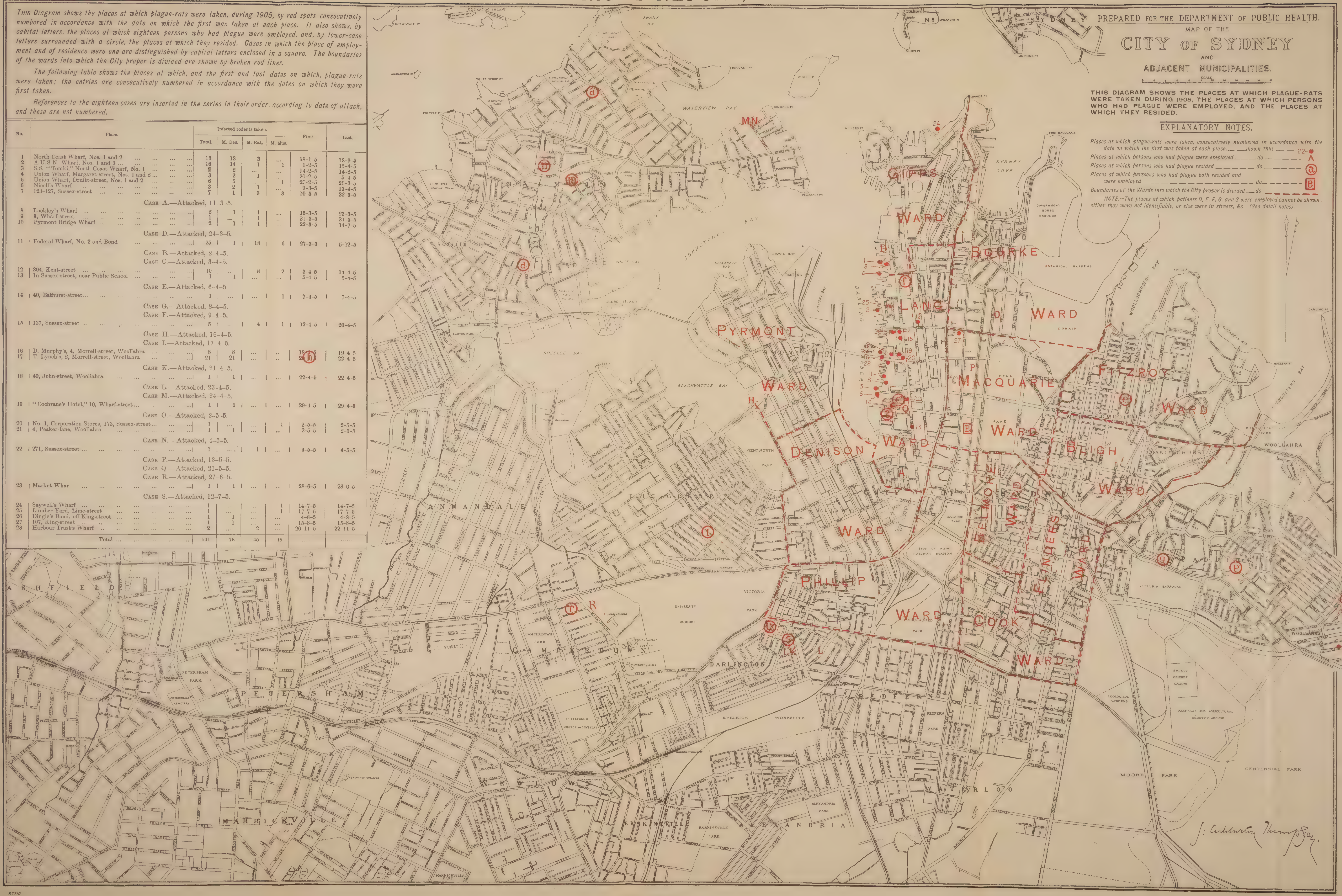
PLAGUE REPORT, 1905.

This Diagram shows the places at which plague-rats were taken, during 1905, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which eighteen persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square. The boundaries of the wards into which the City proper is divided are shown by broken red lines.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the eighteen cases are inserted in the series in their order, according to date of attack, and these are not numbered.

No.	Place.	Infected rodents taken.				First	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
1	North Coast Wharf, Nos. 1 and 2	16	13	3	...	18-1-5	13-9-5
2	A.U.S.N. Wharf, Nos. 1 and 3	16	14	1	1	1-2-5	15-4-5
3	S.S. "Tomki," North Coast Wharf, No. 1	2	2	...	...	14-2-5	14-2-5
4	Union Wharf, Margaret-street, Nos. 1 and 2	3	2	1	...	20-2-5	5-4-5
5	Union Wharf, Druitt-street, Nos. 1 and 2	6	5	...	1	27-2-5	20-3-5
6	Nicoll's Wharf	3	2	1	...	9-3-5	13-4-5
7	123-127, Sussex-street	7	1	3	3	10 3 5	22 3-5
	CASE A.—Attacked, 11-3-5.						
8	Lockley's Wharf	2	1	1	...	15-3-5	23-3-5
9	9, Wharf-street	1	...	1	..	21-3-5	21-3-5
10	Pyrmont Bridge Wharf	2	1	1	...	22-3-5	14-7-5
	CASE D.—Attacked, 24-3-5.						
11	Federal Wharf, No. 2 and Bond	25	1	18	6	27-3-5	5-12-5
	CASE B.—Attacked, 2-4-5.						
	CASE C.—Attacked, 3-4-5.						
12	304, Kent-street	10	...	8	2	5-4 5	14-4-5
13	In Sussex-street, near Public School	1	1	...	...	5-4 5	5-4-5
	CASE E.—Attacked, 6-4-5.						
14	40, Bathurst-street...	1	...	...	1	7-4-5	7-4-5
	CASE G.—Attacked, 8-4-5.						
	CASE F.—Attacked, 9-4-5.						
15	137, Sussex-street	5	..	4	1	12-4-5	20-4-5
	CASE H.—Attacked, 16-4-5.						
	CASE I.—Attacked, 17-4-5.						
16	D. Murphy's, 4, Morrell-street, Woollahra	8	8	...	...	18-4-5	19 4 5
17	T. Lynch's, 2, Morrell-street, Woollahra	21	21	...	...	[illegible]	22 4 5
	CASE K.—Attacked, 21-4-5.						
18	40, John-street, Woollahra	1	1	...	...	22-4-5	22 4-5
	CASE L.—Attacked, 23-4-5.						
	CASE M.—Attacked, 24-4-5.						
19	"Cochrane's Hotel," 10, Wharf-street	1	1	...	...	29-4 5	29-4-5
	CASE O.—Attacked, 2-5-5.						
20	No. 1, Corporation Stores, 173, Sussex-street	1	...	...	1	2-5-5	2-5-5
21	4, Peaker-lane, Woollahra	1	1	...	...	2-5-5	2-5-5
	CASE N.—Attacked, 4-5-5.						
22	271, Sussex-street	1	...	1	...	4-5-5	4-5-5
	CASE P.—Attacked, 13-5-5.						
	CASE Q.—Attacked, 21-5-5.						
	CASE R.—Attacked, 27-6-5.						
23	Market Whar	1	1	...	...	28-6-5	28-6-5
	CASE S.—Attacked, 12-7-5.						
24	Saywell's Wharf	1	...	...	1	14-7-5	14-7-5
25	Lumber Yard, Lime-street	1	...	...	1	17-7-5	17-7-5
26	Dingle's Bond, off King-street	1	1	...	...	4-8-5	4-8-5
27	107, King-street	1	1	...	...	15-8-5	15-8-5
28	Harbour Trust's Wharf	2	..	2	...	20-11-5	22-11-5
	Total	141	78	45	18	......	......



PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1905, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place.— —shown thus — — 22-●
Places at which persons who had plague were employed— — —do — — — — — A
Places at which persons who had plague resided — — — — — — do — — — — — — ⓐ
Places at which persoons who had plague both resided and were employed — — — — — — — — — — — — — — do— — — — — — — B
Boundaries of the Wards into which the City proper is divided —do — — — — — —

NOTE.—The places at which patients D, E, F, G, and S were employed cannot be shown either they were not identifiable, or else were in streets, &c. (See detail notes).

J. Ashburton Thompson.

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REPORT

ON

Outbreaks of Epizoötic and of Epidemic Plague on the Northern Rivers, 1905.

By R. J. MILLARD, M.B., Ch.M. (Syd.), D.P.H. (Camb.),
Assistant Medical Officer of the Government and Assistant Microbiologist to the Board of Health.

The Assistant Medical Officer of the Government to the President of the Board of Health.

Department of Public Health,
27th November, 1905.

THE OUTBREAK AT ULMARRA, ON THE CLARENCE RIVER.

Part I.

General Description of Ulmarra.

Ulmarra is situated on the right bank of the Clarence River (Lat. 29·42 S.), its business centre, which contains stores, two hotels, post-office, &c., being just 9 miles by road or river below Grafton. The district was incorporated in 1871 as a municipality, having an area of 28,000 acres; and this large area, with the exception of the business centre above-mentioned, is entirely rural in character, being occupied by farms chiefly devoted to dairying and the production of maize and sugar-cane. Most farmers combine all three.

Population, Dwellings, &c.—At the census of 1901 population was 1,722. The dwellings were 288, of which it is noted that 277 were of wood, and 77 per cent. contained five or more rooms. These figures are probably approximately correct at the present day.

Soil, Topography, &c.—The municipality has a frontage of about 12 miles to the Clarence River, which forms its western boundary. On the east it is bounded in part by the Coldstream River, a small tributary of the Clarence, and the area thus demarcated is roughly triangular having a southern base of about 7 miles and a northern apex at the junction of the Coldstream with the Clarence. The contour of the country is generally flat, and in consequence of this almost the whole of the municipality is liable to be flooded on the rare occasions when the Clarence overflows its banks. The soil throughout the district is alluvial, of exceptional depth and richness.

Products, Communications, &c.—As already stated, the community is engaged solely in farming pursuits. It exports large quantities of butter, eggs, maize, and other farm produce, and receives general merchandise, as well as empty corn-sacks, egg-boxes, &c. Trade is carried on by steamers. Local steamers ply up and down the river between Grafton and all wharves for more than 30 miles below Grafton. There are altogether some six or seven small steamers thus engaged carrying passengers and goods, and supplying a morning and afternoon service every day. Besides this local trade there is regular communication by ocean steamers with Sydney and Brisbane. The Sydney trade is carried on by the North Coast Steam Navigation Company with a fleet of four steamers, the "Kyogle," "Kallatina," "Nymboida," and "St. George." The two former run regularly between Grafton and Sydney, maintaining a semi-weekly service, and call at all the more important wharves on the river, including Ulmarra. They carry passengers as well as cargo. The two latter carry cargo only, and run less regularly as required by the exigencies of trade. Grafton, the terminal point of the voyage from Sydney, is reachep generally in the afternoon, and the steamer lies there alongside the wharf for two nights and a day before commencing the return voyage. At Ulmarra, as at other wharves, the steamers stop only long enough to discharge or embark passengers and cargo. Between Clarence Heads and Sydney these steamers have no port of call.

The Brisbane trade is very much smaller, and is carried on by one small steamer, the "Pyrmont," which makes weekly trips from Brisbane to the Clarence, calling at Ballina, on the Richmond, both going and coming.

House Accommodation.—The dwellings, generally speaking, are of a good class and comfortably furnished. They are, however, almost universally of wood (96 per cent. at the last census), and mostly have been built a good many years. Both these circumstances are of importance in relation to infestation by rats. Cesspits are common, except on registered dairy premises, on most of which there is a pail-closet of some description, often very primitive. The cesspits are mere holes in the ground, with walls sometimes slabbed, sometimes not, but never water-tight. These pits are almost invariably a happy hunting-ground for rats, and the walls are riddled with rat runs.

The farm buildings, barn, pigsties, cow-bails, are very rarely of a solid up-to-date character, and in many cases are flimsy and makeshift. The ordinary type of barn has a large door at each end, and a roadway by which a cart may be driven through. On either side this roadway inside the barn, are the "straddles" on which the crop of maize, hay, &c., is stacked. In the better-class barns these straddles are platforms raised well off the ground, but in many they are merely planks or fence rails laid on logs which rest on the earth. Such barns offer exceptional attractions to rats, providing abundant food, and a sheltered, seldom disturbed region in which they may burrow and make their nests. In many cases these straddles are not disturbed from year to year, the new crop being carted in on top of the remains of the old. Even when the crop of maize has been bagged and sent away, there remain the husks and the cobs which lie about in heaps and are kept for winter fodder and for fuel respectively. Thus, for one reason or another, many barns never get a thorough turning out.

The pigsties are of the simplest description, the pens are generally floored roughly with fencing rails, and there is often some similar flooring round the feeding troughs. Here again is shelter of which the rats avail themselves.

Sanitary administration in the municipality is practically a dead letter. There is an Inspector of Nuisances, so-called, but he receives only a nominal salary, and, like many of the aldermen, is himself a dairyman. Consequently individual householders are in the main left to follow their own ideas of what is sanitary, undisturbed by any enforcement of the provisions of the Public Health or other Acts. With regard to dairy premises some action has in times past been forced upon the Council by the Board in consequence of reports of the Board's Veterinary Inspectors, but the general condition of these premises shows that there has been no continuous supervision by the local authority or attempt to require provision of suitable structures and observance of cleanly methods. Untidiness of premises and uncleanliness of bails and yards are the prevailing characteristics, and in the methods adopted in the actual milking there is very little regard for cleanliness.

PART II.

PLAGUE IN MAN.

The first intimation to this Department of Plague in the Clarence River District was conveyed in a telegram from Dr. Page, of South Grafton, received on 4th January, 1905, in which he reported his strong suspicions as to nature of illness of P.C. (Case D), then a patient in his private hospital at South Grafton.

In accordance with your instructions, I at once proceeded overland to Grafton, taking with me an experienced sanitary inspector, a laboratory assistant, and a rat-catcher, together with an equipment of microscope and other necessaries for bacteriological examination, a spray pump and disinfectant, and a supply of rat-traps.

On my arrival at Grafton on 7th January, 1905, I was able from examination of the patient P.C. and of microscopical preparations from his bubo to confirm Dr. Page's diagnosis of bubonic plague. Also, I obtained particulars of 5 other cases of suspicious illness which had occurred in the Ulmarra district in the past three weeks. Four of these had had a rapidly fatal termination, whilst the other case had reached the stage of convalescence. The information supplied by the medical attendants, and by the friends and relatives, showed fairly conclusively that these four deaths had been due to plague. Examination of the convalescent case showed that he had still a femoral bubo, from which I obtained material which contained the *Bacillus pestis.* This was demonstrated in the Board's laboratory morphologically, culturally, and by inoculation.

The first of these cases was attacked on 14th December, 1904. Careful search of the death register and inquiry of the local medical practitioners failed to discover any prior case which was in any way open to suspicion of having been of the same nature. In a rural district like Ulmarra it is comparatively easy to learn the comings and goings of any strangers, and the movements of the members of any given household. There was, however, nothing to suggest that E.W. (Case A) had been in any way associated with any infected person.

I remained in the district until 11th March, during which period there were 6 other cases. Two months after my departure 1 other case occurred, after which there were no more for the rest of the year.

The epidemic thus extended over the period, 14th December, 1904, to 6th May, 1905, the attack dates of the 13 cases being as follows:—

14th December	Case A.
29th „	„ B and C.
30th „	„ D and E.
1st January	„ F.
21st „	„ G.
22nd „	„ H.
23rd „	„ J.
26th „	„ K and L.
27th „	„ M.
6th May	„ N.

Thus there was an interval between Cases A and B of 15 days, between F and G of 20 days, and between M and N of 99 days.

Several other cases were reported to me as possibly cases of plague, but in all I was able to negative this diagnosis, and I have no reason to suppose that any cases of plague occurred which were not reported.

In the beginning of May (the date of attack of Case N), during my absence from the district, two Hindoo farm labourers, Booda, aged about 50 years, and his nephew, Dola, aged 25 years, died on 4th May and 10th May respectively, after only a few days' illness. The latter of these two cases was admitted to the Grafton Hospital and was reported as possibly a case of plague, but after full inquiry into the circumstances it seemed more probable that both Hindoos had died of ordinary pneumonia.

The circumstances connected with the 13 cases of plague were as follows:—

Case A.—Wilcox, Elizabeth M.

Summary.—Female, æt. 24 years; single; domestic duties. No former attack; never inoculated; no communication with any previous case. Resided with her grandparents, Kelly by name, in a farmhouse on the right river bank, about 4 miles below the township of Ulmarra. Attacked 14th December, died early on 17th December. Right inguinal bubo. No bacteriological examination.

Movements prior to attack.—Had not been away from the district for a very long time, but was a frequent visitor at Clarke's farm (*vide* Case D), and on Sunday afternoon, 11th December, *i.e.*, about 60 hours before she was attacked, had sat in Clarke's barn, where sick and dead rats were already at that date being observed, and whence, on 9th and 10th January, there were obtained 50 rats and 65 mice in a mummified condition.

History of Illness.—The following account was obtained from her relatives and her medical attendant:—Was in her usual good health when she went to bed on 13th December. 14th December: Felt ill on waking; bad headache; seen by doctor about 3 p.m.; then had temperature 105°, severe headache, bloodshot eyes, and abdominal pain. 15th December: Seen by medical attendant 11 a.m.; temperature 103·2°; felt better, but abdominal pain was severe, and she now had pain and acute tenderness in right groin; peritonitis was suspected, but bowels were freely open and abdomen not distended. 16th December: Seen by medical attendant at 11 a.m.; temperature 102°; said she felt better and that she had no pain, but the abdomen was found to be still tender; during the next night she complained of feeling cold, and she died quite suddenly in the early morning of 17th December. Cause of death was certified by her medical attendant as "Peritonitis, Syncope."

Residence.—A comfortable, cleanly kept farmhouse, near the river bank.

Rats.—At her residence, no history of dead or sick rats was obtainable, nor were any indications of such found when the premises were carefully searched on 9th and 10th January. The finding of sick and dead rats at Clarke's barn, where she had sat 60 hours before her attack, has already been mentioued.

Further cases.—There were no further cases at her place of residence.

CASE B.—PLUMMER, VINCENT.

Summary.—Male, æt. 17 years; single; farm-worker. No former attack; never inoculated; no communication with any previous case. Resided with his parents on the bank of the river, and about half a mile below the residence of Case A, and about 4½ miles below Ulmarra township. Attack, 29th December; convalescent on 3rd January. Left femoral bubo. Morphological, cultural, and inoculation tests positive.

Movements prior to Attack.—Had not been away from the district for many weeks; had been to Ulmarra township frequently.

History of Illness.—Supplied by his relatives, his medical attendant, and himself:—29th December: He was taken suddenly ill about 10 a.m.; "went in the legs," and was thought to have sunstroke; on the same morning he noticed a left femoral bubo. 31st December—Temperature—morning, 104·2° F.; evening, 103°; delirious at night. 2nd January—Seen at noon by medical attendant; had temperature 104°, seemed very ill, and was muddled and stupid, unable to answer questions. 3rd January—Temperature normal; on this day he got up to attend his father's funeral, and he did not go back to bed. Seen by me on 8th and 9th January; pulse and temperature normal; says he feels perfectly well; looks somewhat languid; bubo, left femoral, still present, rather larger than an unshelled almond, and slightly tender on manipulation; no skin lesion on the drainage area of the femoral group of glands. On 9th January I punctured the bubo with a sterile hypodermic syringe, and withdrew a small quantity of material. Smears of this showed no bacilli, but an agar culture made at the same time gave a growth which was subsequently proved both morphologically and by inoculation to be *Bacillus pestis.* His subsequent history was uneventful; he resumed ordinary work, and the bubo gradually resolved.

Residence.—A farmhouse of fairly good construction, but badly infested with fleas. The barn is about 15 yards from the house. After the death of the parents the family abandoned this residence and built another.

Rats.—When search was made by the staff, on 8th January, 3 rats and 1 mouse were found dead and mummified in the barn. No live rats were seen or caught. No history could be obtained of any dead or sick rats about the place; but the complete absence of live rats at the time of the examination of the premises suggested that they had been driven away by some unusual cause, since the barn offered abundant food and shelter. Subsequently, infected rats were obtained at points on the river bank both above and below these premises.

Contacts and Further Cases.—At the residence the household comprised, besides the patient, his father and mother, two sisters, and a brother. The father and mother both became infected (Cases E and F), as did also a frequent visitor to the house (Case C).

CASE C.—CAMPBELL, EDWIN BRIGGS.

Summary.—Male, æt. 34 years, single, farmer; no former attack; never inoculated; no communication with any previous case. Resided some 6 miles from Ulmarra township, near the Coldstream River. Attacked on 29th December, died on 1st January. No bubo was observed; bacteriological tests were not made.

Movements prior to Attack.—He had not recently been away from the district; went frequently to Ulmarra, and was a frequent visitor at the home of Cases B, E, and F. He spent Christmas Day there, and was there again on 28th December.

History of Illness.—The following account was obtained from his medical attendant and from his relatives:—29th December—He was taken suddenly ill during the evening with aching of limbs and of body generally; was thought to be suffering from sunstroke. 30th December—Seen by his medical attendant for the first time soon after midnight; headache, intense; temperature, 105° F; heart apex displaced outwards, mitral murmur; no tenderness anywhere. 31st December—Morning temperature, 101° F; felt generally better, but had had a sleepless night, with much vomiting. 1st January—Seen by his medical attendant about 10 a.m.; he had had no sleep; temperature was 103·5 F; vomiting had ceased, but he was suffering from diarrhœa; about 10·30 a.m. he had a drink, felt inclined to vomit, sat up to do so, and at once died. The body became rapidly discoloured after death, so as to be soon unrecognisable. The cause of death was certified by his medical attendant as "Syncope, due to chronic cardiac disease," but the case was probably one of Septicæmic Plague.

Residence.—The residence was a perfectly new, good-class, wooden cottage, in which he had been living only a few weeks. It was situated about 6 miles from Ulmarra, and 3 or 4 miles from the nearest place at which infected human beings or rodents were found.

Rats.—No rats were found at the residence. As above stated, this patient was a frequent visitor at the home of Cases B, E, and F. Mention had already been made of the rats in connection with these premises.

Contacts and Further Cases.—At his residence, 1 contact. No further cases occurred here.

Case D.—Clarke, Percy.

Summary.—Male, æt. 25 years; single; farm-worker; no former attack; never inoculated; no communication for at least 13 days with any previous case. He had been associated with Case A; but she died on 17th December. Resided on his father's farm premises, about 1½ mile below Ulmarra township, on the right bank of the river. Attacked 30th December, about 10 p.m.; strangulated femoral hernia diagnosed. Removed to private hospital in South Grafton on 1st January; reported by medical attendant as plague on 4th January. Seen by me on 7th January; remained in hospital till 17th February; right femoral bubo; smear showed abundant *B. pestis.*

Movements prior to Attack.—Had not been away from Ulmarra; had been occupied about the farm.

History of Illness.—30th December, about 10 p.m., was taken suddenly ill with rigor, intense headache, aching in limbs and back, vomiting, and acute pain in right groin. 31st December—Prostrated and semi-delirious; bubo about size of walnut; bowels constipated; much vomiting; strangulated femoral hernia diagnosed by his medical attendant, and removal to private hospital, South Grafton, arranged. 1st January—Admitted to hospital in early morning and at once operated on; incision disclosed no hernia, but acutely inflamed hemorrhagic femoral gland, which was removed. Smears made from this gland showed abundant *B. pestis.* Temperature, which on admission was 105°, fell that evening to 99·2° at 6 p.m.; but he remained in a condition of muttering delirium, which continued for 4 days, and the temperature rose again next day to 101·6° at 2 a.m.; and for the next 5 days reached 102° at some period of each day, this alternating with drops to normal; the pulse throughout remained about 110 and soft. 7th January—I saw the patient for the first time; the wound had been stitched, but showed no tendency to heal, and on this day the stitches were removed and antiseptic foments applied to promote the separation of the sloughs which had formed; the subsequent course of the case was tedious and prolonged, owing to the suppuration of some deep-seated inguinal glands. Patient left hospital on 17th February, 1905, with sinus still discharging.

Residence.—The actual residence, a large comfortable wooden cottage, was on one side of the main road, and on the other side, between the road and the river bank, was the barn, as well as other farm buildings. This barn was of the inferior type described above, the "straddles" being merely logs and fence rails laid on the ground.

Rats.—About the barn numerous dead and sick rats were found early in December, and when the place was thoroughly turned out by the staff, on 9th and 10th January, 50 rats and 65 mice were found, but all in a mummified condition, which precluded any bacteriological examination as to the cause of death. Poison had not been laid here, and it was evident that the mortality had been due to an epizootic.

Contacts.—A large family—parents, brothers, and sisters—lived at the same residence with the patient. No further cases occurred here.

Case E.—Plummer, Henry.

Summary.—Male, æt. 65 years; married; farmer; no former attack; never inoculated. Lived in same residence with Case B. Attack on 30th December, about 3 a.m. (17 hours subsequent to the attack of Case B); died 2nd January, about 4 p.m. No bubo observed; no bacteriological examination.

Movements prior to Attack.—Had not been away from district; had been to Ulmarra occasionally on business.

History of Illness.—Supplied by his relatives and his medical attendant. Patient had an inguinal hernia, and was subject to occasional attacks of vomiting, believed to be connected with this; he was, however, in his usual health up to 30th December. 30th December—Shivering and vomiting came on about 3 a.m., and, later, vertigo and diarrhœa; during the afternoon his temperature was 104°. 2nd January—On this day, about noon, he was seen for the first time by his medical attendant, who found temperature and pulse normal, hernia down, but reducible without pain; patient complained of nothing but the intense heat of the weather (it was 117° F. in the shade that day); about 4 p.m. he collapsed and died suddenly; the cause of death was certified as "Heat exhaustion and syncope," but, on consideration of the history and circumstances, I am of opinion that this was a case of Septicæmic Plague.

Residence, Rats, Contacts.—*Vide* under Case B.

Case F.—Plummer, Mary Ann.

Summary.—Female, æt. 60 years, wife of Case E; no former attack; never inoculated. Lived with Cases B and E. Attack on 1st January, about 8 p.m. (*i.e.*, about 90 hours subsequent to Case B; died 4th January, about 3 a.m.; duration of illness, 55 hours; left femoral bubo; no bacteriological examination.

Movements prior to Attack.—She had not been away from home for many weeks, except to go occasionally to Ulmarra.

History of Illness (as supplied by relatives and medical attendant).—She had been in her usual health, attending to her husband and son (Cases B and E) up to the evening of 1st January. About 8 p.m. had a rigor, then headache, vomiting, and general aching; was delirious during the night, with temperature 103° F. 2nd January—Seen about noon by medical attendant; then had severe headache, temperature 105°, and tongue furred and dry; delirious again during the night, with more vomiting. 3rd January—Seen by medical attendant shortly before midnight; was then dying; temperature, 104·3°; she had complained of pain in left thigh, and there was now a definite tender induration in the left Scarpa's triangle. 4th January—Died about 3 a.m.; cause of death certified as "Heat exhaustion—syncope."

Residence, Rats, Contacts.—*Vide* under Case B.

Case G.—Donaldson, James.

Summary.—Male, æt., 25 years, married, store employee; no former attack; never innoculated; no communication with any previous case. Residence, Grafton Road, Ulmarra, about 200 yards from place of employment, Retallick's general store. Attacked, 21st January. Notified by his medical attendant at 10 a.m. on 22nd; seen by me at 11·30 a.m., and admitted to Grafton Hospital 6 p.m. on the same day; discharged from hospital, 24th February; duration of illness, 34 days. Left femoral bubo; morphological and cultural tests positive.

Movements before Attack.—Had not been away from Ulmarra for many weeks, except for an occasional visit to Grafton.

History of Illness.—20th January—After working at pulling weeds all the morning, noticed about 1 p.m. that back was painful. Had no shivering or other symptom, and paid little attention to the pain. Had an uneasy night on account of pain in back. 21st January—Went to work as usual at 6·30 a.m. During the day pain in back became worse, and in the afternoon he noticed tender spot in left groin. About 4 p.m. went home, unable to work any longer. Seen and treated on same evening by his medical attendant, who reported the case next morning. 22nd January—Seen by me at 11·30 a.m. In bed. Flushed, with suffused eyes. Complains of headache, giddiness, and painful lump in left groin; temperature, 103·4°; pulse, 112, with tendency to dicrotism. Bubo is a left femoral gland about the size of a marble, slightly prominent above the surface. No cuts or wounds on leg or foot. Two fading papules—possibly flea bites—on inner surface of left thigh. Fluid from bubo, withdrawn with hypodermic syringe, did not show any bacilli, but the diagnosis being clinically definite, I injected at 1 p.m. 60 c.c. Yersin serum (L.I.P.M.) into right chest wall, and made arrangements for his removal at once to Grafton Hospital. This was accomplished during the afternoon, and he was admitted at 6 p.m.

At 1 p.m. (injection of serum), temperature 104; at 2·30 p.m. (on leaving home) temperature 105·4°; pulse, 116. At 6 p.m. (on admission to hospital), temperature, 104·6°; pulse, 124. At 9 p.m. another injection (40 c.c.) of serum was given. During the night he vomited, was slightly delirious, and had retention of urine. At midnight, temperature, 105·6°; pulse, 120. 23rd January—Temperature, 8 a.m., 104·8°; 8 p.m., 102·8°; pulse, 8 a.m., 116; 8 p.m., 96. Vomited again 10·30 a.m. At 11·20 a.m. further injection of serum (40 c.c.). Is also having a mixture containing quinine and digitalis. Further specimen obtained this day by puncture of bubo showed *B. pestis* in smear and in culture. At night very restless; no sleep after 1 a.m. Vomited frequently. 24th January—Temperature, 8 a.m., 102·4°; 8 p.m., 103·6°; pulse, 8 a.m., 94; 8 p.m., 96. Suffered a great deal with backache and a troublesome cough. Towards evening and at night was delirious, and slept only after trional gr. 30. Bubo painful. 25th January—Temperature, 4 a.m., 103·8°; 8 a.m., 101·8°; 8 p.m., 102·4; pulse, 8 a.m., 96; 8 p.m., 120. Delirious and restless all day; very delirious at night. Further injection of serum (40 c.c.) at 8·45 p.m. 26th January—Temperature, 8 a.m., 102°; 8 p.m., 102·4°; pulse, 8 a.m., 100; 8 p.m., 116. Very restless and delirious all day. Had slight epistaxis at 11·30 a.m.; pulse intermittent at times; respiration rapid, 48 most of afternoon; had a good night; slept soundly. 27th January—Temperature, 8 a.m., 101·2°; 8 p.m., 101·5°; pulse, 8 a.m., 104; 8 p.m., 96. General condition during day better. Bubo very painful. At night very restless, and delirious from 10·30 p.m. 28th January—Temperature, 8 a.m., 100·8°; 8 p.m., 101°; pulse, 8 a.m., 96; 8 p.m., 88. Condition much improved. Slept well all night. 29th January—Temperature, 8 a.m., normal; 8 p.m., normal; pulse, 8 a.m., 80; 8 p.m., 92. From this onward, progress was steady. 2nd February—Bubo was freely opened. 9th February—Large slough separated. 3rd March—Discharged convalescent. Wound had almost healed, and he was able to hobble about with a stick, though much pulled down by his illness.

Residence.—A comfortable cleanly-kept cottage, between Grafton Road and the river bank, about 300 yards above the public wharf.

Employment.—Retallick's general store; clean and well kept, but next door to the "Exchange Hotel" (*vide infra.*) The back yards are separated by an open fence only.

Rats.—At residence there was no evidence of rats, and none could be caught. At employment, there were found in the store stables on 23rd January, 1 putrid and 1 skeleton rat, as to which the cause of death could not be ascertained. In the stables and outhouses of the adjoining "Exchange Hotel" there had been found on 11th, 12th, and 13th January 42 plague-infected rats; and in a shop next door on the other side there were found on 23rd and 24th January 3 dead rats; but these last were too putrid for determination of the cause of death.

Contacts and Further Cases.—At residence, 3 contacts; at employment, 4. No further cases occurred at either place.

CASE H.—YOUNG, HARRIET ISABEL.

Summary.—Female, æt., 49 years. Single; domestic duties; no former attack; never inoculated; no communication with any previous case. Residence and employment at her father's house at Cowper, about 6 miles below Ulmarra township, on the right bank of the river. Attack, 22nd January. Notified by her medical attendant on 23rd January. Seen by me at 3 p.m. the same day, and again on 24th. Admitted to Grafton Hospital at 12·30 p.m. on 25th. Discharged 24th February. Duration of illness, 34 days. Bubo, left femoral. Morphological and cultural tests positive.

Movements before Attack.—Had not for months been further away from her home than to go to her next-door neighbour, or to the church close by.

History of Illness.—22nd January. Having gone to bed overnight in usual health, vomited at 6 a.m. and felt feverish. Seen by her medical attendant, who found some pyrexia. Stayed in bed. 23rd January—Seen by me at 3 p.m.; temperature, 102·2°; pulse, 112. In left groin there was definite enlargement of a femoral and an inguinal gland, which were not, however, tender. Fluid from this bubo showed no definite bacilli. 24th January—At 1 p.m., temperature 103°; pulse, 98; dropped a beat occasionally. Enlarged glands about same. Further specimen of gland juice obtained this day showed *B. pestis* in smear and culture. 25th January—Patient admitted to Grafton Hospital at 12·30 p.m. At 8 p.m. temperature 102·8°; pulse, 100; respiration, 40. Slept well at night. 26th January—Temperature, 8 a.m., 101°; 8 p.m., 100°; pulse, 8 a.m., 108; 8 p.m., 96. Drowsy all day, and slept well at night. 27th January—Temperature, 8 a.m., 99·2°; 8 p.m., 99·8°; midnight, 102°; pulse, 8 a.m., 84; 8 p.m., 84. Comfortable all day, but at night complained of severe pain in right shoulder. Bubo somewhat painful. 28th January—Temperature, 8 a.m., 99·6°; 8 p.m., 100·6°; pulse, 8 a.m., 94; 8 p.m., 92. This patient's course was uneventful. By 30th January temperature had fallen to normal, and it remained so with the exception of a rise to 101·4° at 8 p.m. on 5th Februay. The bubo was indolent, never acutely tender, and gradually diminished in size, though not subsiding entirely. 24th February—Discharged.

Residence.—A roomy but old cottage, situated on the river bank, near Cowper, about 6 miles below Ulmarra township. In some of the back rooms and in the kitchen the floor joists had partly rotted away, letting the floor boards down on the earth. The closet was an old cesspit.

Rats.

Rats—The premises were cleansed and searched on 26th and 27th January, when 16 rats and 1 mouse were found dead; 7 of these were putrid, the rest skeletons. In none could the cause of death be determined; but it was ascertained that poison had not been laid. Six putrid rats and 4 skeletons were found under the back verandah and under the floor of a back room occupied by the patient. The rest of the rats and the mouse were found in the buggy shed and barn.

Contacts and Further Cases.—Two other persons lived at the same residence; but there were no further cases.

CASE J.—PAINE, WILLIAM.

Summary.—Male, æt. 37 years; married; store employee; no former attack; never inoculated; no communication with any previous case. Residence in Ulmarra township, a few hundred yards from Glisson's store, where he was employed. Attacked 23rd January, 8 p.m.; notified by his medical attendant on 24th January, about 3 p.m.; seen by me at 3·30 p.m. same day. Admitted to Grafton Hospital on 27th January, at 4 p.m.; died, 30th January, at 9 p.m; duration of illness, 7 days. Septicæmic plague; no bubo. Morphological and cultural tests positive.

Movements before Attack.—He had not been out of the district, but his daily duty was to drive a hawker's van round from farm to farm.

History of Illness.—23rd January—Began to have "bilious" headache after midday; ate no tea; head worse in evening—felt giddy; slept fairly well. 24th January—Went to work at 6·30 a.m., though feeling giddy and weak, and retching occasionally; about 11 a.m., while out in country driving a van, he vomited and collapsed, incapable of further effort; suffered severe headache; at 3·30 p.m., temperature 105°, pulse 128; severe headache and prostration; no bubo to be found; at 8·50 p.m., more prostrated and semi-stuporous; temperature, 104·6°; pulse, 128; injected Yersin serum, 60 c.c.; took pipette of blood from finger, which showed no *B. pestis* in smear or culture. 25th January—At 2·25 p.m., much improved, bright and intelligent again, temperature 102·2°, pulse 102; still inclined to vomit after food or drink; at 4·40 p.m., temperature, 101·8°; pulse, 108; injected Yersin, 40 c.c. 26th January—Had a fairly good night till midnight, after which he vomited violently many times; at 2 p.m., clear-headed, but complaining of headache; temperature, 104·8°; pulse, 108; no bubo; injected Yersin, 60 c.c. 27th January—7 a.m., temperature, 104°; Yersin, 60 c.c., injected; admitted to Grafton Hospital, 4 p.m., temperature, 105·2°; pulse, 107; Yersin, 40 c.c., at 4·30 p.m. 28th January—Temperature, 8 a.m., 100·8°; 8 p.m. 106°; pulse, 8 a.m. 118, 8 p.m. 136; respiration, 8 a.m. 44, 8 p.m. 50; very ill; respiration rapid, but no physical signs of lung disease; no bubo. 29th January—Temperature, 8 a.m. 100°, 8 p.m. 103·4°; pulse, 8 a.m. 120, 8 p.m. 126; respiration, 8 a.m. 58, 8 p.m. 59; stuporous all day, delirious at night; severe dyspnœa at 3 p.m.—became very cyanosed; impaired resonance and some moist rales at left base; tenderness over left zygoma, immediately in front of ear-lobe. 30th January—Temperature, 8 a.m. 104°; pulse, 8 a.m. 140; respiration 70; drowsy, but not unconscious; over left zygoma a hard tender gland, about size of haricot bean; gradually became unconscious, and died about 9 p.m. 31st January—*Post-mortem* examination ten hours after death; rigor mortis slight; *post-mortem* lividity not well marked; no bubo, but parotid lymphatic gland was about size of haricot bean, and a deep inguinal gland on the right side was enlarged. Abdomen: No petechial hæmorrhages, peritoneal fluid not excessive, appendix normal; spleen large, hard, and firm, rather darker than normal; liver enlarged, firm, and pale; surface and substance riddled with small necrotic patches, $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in diameter; kidneys large and pale, capsule slightly adherent, cortex not diminished, no hæmorrhages; iliac and mesenteric glands generally somewhat enlarged. Chest: Left lung base almost solid and very dark, sank in water; no pleurisy; some infarcts, size of a pea, on the surface; right lung fairly normal; heart, no gross change; skull, not opened. Microscopically, smears from liver showed very abundant bacilli, morphologically identical with *B. pestis*; smears from spleen and left lung base showed a few bacilli doubtfully similar. Cultures from liver showed *B. pestis* pure; spleen showed no growth. Lung showed pneumococcus and streptococcus pyogenes.

Residence.—A comfortable, cleanly-kept, new cottage. No stable. Pail closet.

Employment.—General store, fairly well kept, but with the usual amount of ramshackle outbuildings, cases, and rubbish.

Rats.—None obtained at either residence or employment. At the Police stables, and at McMahon's timber yard, two doors from the store where patient was employed, 9 infected rats were found on 28th January.

Contacts and further Cases.—At the residence, his wife and mother nursed him for four days, and there were three children in the house. At the place of employment there were five or six other employees. No further cases occurred at either place.

CASE K.—SMALL, IRENE.

Summary.—Female, æt. 16 years; single; domestic duties. No former attack; never inoculated. No communication with any previous case. Residence on outskirts of Ulmarra township, off the Coldstream-road, and about half a mile in a direct line from the post office. Attack on 26th January. Seen by me on the same day during inspection of residence. Admitted to Grafton Hospital on 28th January; discharged on 13th February; duration of illness, 19 days. Bubo, right femoral.

Movements before Attack—She had not been away from Ulmarra for many weeks. Had been mostly occupied in and about the residence.

History of Illness.—26th January: Had been in good health previously; on this day, after breakfast, noticed tender spot in right groin; after lunch, noticed headache and felt cold; at 5·20 p.m. temperature, 100·2°; pulse, 120; bowels had acted yesterday and this morning; was up and about, but looked pale; at night restless, headache, and rigors. 27th January—Got up about 10 a.m., but head ached, and she felt ill; vomited during morning; at 1 p.m., temperature, 104·6°; pulse, 128; headache; "strawberry" tongue; tender femoral gland in right groin; 3 p.m., temperature same; injected Yersin serum, 40 c.c.; 9 p.m., temperature, 105·2°; vomited twice during the night. 28th January—8 a.m., temperature, 102·6°; pulse, 132; removed to Grafton, and admitted to hospital at noon; temperature, 4 p.m. 103°, 8 p.m. 102°;

pulse, 4 p.m. 120, 8 p.m. 116; slept comfortably at night. 29th January—Temperature, 8 a.m. 101·2°, 4 p.m. 104·2°, 8 p.m. 102·4°, pulse 8 a.m. 116, 4 p.m. 100, 8 p.m. 120; specimen obtained by puncture of bubo showed no bacilli in smear or culture; at night delirious and very restless, trying to get out of bed. 30th January—Temperature, 8 a.m. 102·8°, 8 p.m. 101°; pulse, 8 a.m. 120, 8 p.m. 120; at 9·40 a.m. 40 c.c. Yersin injected; severe headache in morning; more comfortable at night; slept well at night. 31st January: Temperature and pulse normal; slight rash on chest. 1st February—Normal temperature and pulse; from this onward her convalescence was uneventful, and on 13th February she was discharged.

Residence.—Consisted in part of a good, fairly new cottage, well raised off the ground, in part of a very old cottage, with floor-joists embedded in the earth, and roof of shingles covered with iron. This older part contained two rooms used as a dining-room and bed-room respectively. The bed-room had been occupied by the patient on night of 24th January.

Rats.—On the evening of 24th January a sick rat was noticed just outside the dining-room. It was so feeble that one of the family put a tin over it, and brought word of the matter to one of my staff. Examination showed that it was plague infected. Next day, 25th January, I had the floors of the cottage taken up. One dead rat, plague infected, was found under the dining-room doorway, and the ground was riddled with rat runs. On 26th January, 2 infected and 1 putrid rat were found on the premises, and during the next four days as a result of thorough investigation which involved, amongst other things, the turning over of a barn full of hay, in all 20 plague-infected rats were obtained. Of these, 18 were found under the floor of a buggy shed situated about 200 yards from the house.

Contacts and further Cases.—The household usually comprised father, mother, three daughters, and two boys. No further cases occurred among these, but a brother of this patient who lived at a distance and came home at each week end was attacked (*vide* Case M).

Case L.—McCooey, John.

Summary.—Male, æt. 53 years, married; carrier; no former attack; never inoculated; no communication with any previous case; no fixed residence or place of employment. Attack, 26th January; seen first by medical attendant on 27th January; died, 28th January, at 4 a.m.; duration of illness, 36 hours; case not notified until after death. Septicæmic plague confirmed by autopsy and by morphological and cultural tests.

Movements before Attack.—On 21st January he came to Ulmarra from Grafton. Stayed the night in Ulmarra, at Niland's. 22nd January—Returned to South Grafton for the night; stayed at Holmes's, South Grafton. On 23rd January returned to Ulmarra, and camped near McMillan's barn, on the river bank, about 1½ mile below Ulmarra. He had been engaged to remove the household effects of a family named McClennan, who were staying with the McMillans. These goods were stored in the barn, and McCooey was occupied on 23rd and 24th January in packing them on his dray. Each night he slept under his dray near the barn, and he complained at the time that he was "nearly eaten alive" by the fleas there. On January 25th, at daybreak, he started with the dray and furniture, and was on the road when attacked.

History of Illness (from information supplied by his friends).—26th January—While on the road, became very ill during the afternoon. Vomited, and complained of severe pain in the back. At night was delirious, and obviously very ill. During the night was conveyed by friends 10 miles to Laurence, and next morning (27th January) was taken by steamer to friend's house at South Grafton. 27th January—Seen at South Grafton by medical attendant during morning. Temperature then 102°. Vomiting had ceased. Spleen was found somewhat enlarged, but there was no bubo. A provisional diagnosis of influenza was made. During the day patient became worse again, pain in back returned and was very severe, and he was delirious. Condition was still worse at night. 28th January—Died at 4 a.m., after not more than 36 hours' illness. The case was now notified to me as possibly plague. *Post-mortem* examination, made 7½ hours after death, yielded the following information:—

Rigor mortis was well marked. Dependent parts, ears, and neck livid; skin showed many flea-bites, also many small subcutaneous *petechiæ.*

Abdomen.—Vessels of omentum were congested, and there were sub-serous hæmorrhages throughout the peritoneal cavity, on liver, kidneys, and intestinal walls; spleen greatly enlarged.

Thorax.—Pleural and pericardial fluid increased; no pleuritic adhesions; hæmorrhages on surface of lungs; lungs moderately congested.

Microscopic.—Smears from spleen showed abundant bipolar stained plague-like bacilli; cultures from spleen, liver, and heart's blood gave pure growths of *B. pestis.*

Residence.—As above described, he had no fixed abode for five days. The barn near which he was camped on 23rd and 24th January was fairly well constructed, with the "straddles" raised from the ground, but it was badly infested with fleas.

Rats.—At McMillan's, no history or dead or sick rats, and when the premises were turned out, on 31st January, very few rat runs, and no sign of recent infestation. The skeletons or mummies of 13 mice were found in the barn, and, in the same place, another mouse, still putrid. There was no indication of the cause of death of these mice. At Niland's, the only other Ulmarra premises where he was known to have been for any time, search was made, and traps were set on more than one occasion, but no rats were obtained.

Contacts and further Cases.—At McMillan's there was a household of five or six. No further cases occurred.

Case M.—Small, Ellis.

Summary.—Male, æt. 25 years, single; school-teacher; no former attack; never inoculated. Brother to Case K, but had not seen her since her attack. Resided and taught at Glenreagh, some 28 miles from Ulmarra, but returned home to Ulmarra each week end. Attacked, 27th January. Seen by me, 28th January; died, 1st February. Duration of illness, 5 days. Bubo, right cervical; morphological and cultural tests positive.

Movements before Attack.—On 21st January he came from Glenreagh to Ulmarra, and stayed at home till 2 p.m. on 22nd January, when he started on the return journey to Glenreagh; remained at Glenreagh till the morning of 28th January, when he started for Ulmarra, arriving home in the afternoon.

History of Illness.—26th January—Went to bed in his usual health. 27th January—On waking, "felt pains all over"; about 8·30 a.m. began vomiting, and this continued till afternoon; had some diarrhœa at same time; slept very little at night. 28th January—Still feeling ill, but drove 28 miles to his parents' residence at Ulmarra. Seen first by me at 3·45 p.m.; temperature, 103°; pulse, 120; tongue, clean; no bubo nor tenderness anywhere; headache; vomited again during the night. 29th January—11·30 a.m. temperature 102·4; headache gone; 2 p.m., temperature 103°, pulse 116; said he felt better; no bubo anywhere; blood taken this day from finger gave no bacilli in smear or culture; at night slept well, but vomited three times. 30th January—Noon, temperature 101°, pulse 106; has a small sore on right side of the neck, which is sloughing in the centre. 31st January—3·30 p.m., temperature 100·4°, pulse 102; felt better in every way, no more headache nor vomiting. The sore in neck above mentioned had been incised during the morning by his medical attendant, who subsequently informed me that only a few drops of dark blood escaped as a result; I did not see it, as it was freshly bandaged. His condition had obviously much improved in the last three days, and the only symptoms suggestive of plague were the sudden acute onset with vomiting, and the known exposure to risk of infection 5 days previously. (Case K was his sister, living at parents' residence, where he had been on 21st and 22nd January). Also, liver and spleen were found, on percussion, to be slightly enlarged. 1st February—After having had a fairly good night, but with some restlessness, he took a sudden change for the worse about 6·30 a.m., and when seen by his medical attendant at 8 a.m. was manifestly dying; he became rapidly weaker, though conscious to the last, and died at 9 a.m. Post-mortem examination at 11·30 a.m., 2½ hours after death; body already becoming livid, rigidity not well marked; on removing neck bandage, there was obvious a large brawny swelling over right sterno mastoid. His medical attendant, who was present at the autopsy, said there was no such swelling at noon the previous day, when he incised the sore as above described. On that occasion he was able to pinch up the affected skin in his fingers when making the cut. On opening the body, *liver* was enlarged and pale, no necrotic patches or hemorrhages; *spleen* was enlarged, smooth, and of fairly normal colour and consistence, no hemorrhages nor necrosis; *kidneys* fairly normal, no subserous hemorrhages; *lungs*, normal; *heart*, right side engorged, pericardial fluid much increased; *microscopic*—swelling in neck, smear showed abundant *B. pestis*, and culture was a pure growth of the same, similar bacilli were found in smears from liver (scanty), spleen (abundant), heart-blood (scanty). In this case it seems evident that the site of inoculation was the sore in the neck, which was, in fact, a plague carbuncle. The rapid formation of the swelling in the neck and fatal issue of the case within 24 hours of incision of this carbuncle, the course of the disease having previously tended definitely towards recovery, suggests the possibility that the incision may have been the means of introducing virulent bacilli into the blood-stream, and so producing septicæmia. Examination of blood taken from finger on 29th showed that at that date there were no bacilli in the blood.

Residence.—Glenreagh is a small and isolated village, and the school and residence clean and well kept. The Ulmarra residence has already been described under Case K.

Rats.—At Glenreagh inquiries failed to show any evidence of epizootic plague. The evidence of epizootic plague at the Ulmarra home has already been given in regard to Case K.

Contacts and further Cases.—At Glenreagh, many contacts, but no further cases. At Ulmarra, *vide* under Case K.

Case N.—Connear Martin.

Summary.—Male, æt. 68 years, labourer; no former attack; never inoculated; no communication with any previous case. Residence and place of employment at D. K. McLachlan's, on Grafton Road, about 2 miles from Ulmarra. Attacked 6th May, at 10 a.m. Admitted to Grafton Hospital, 9th May; died, 10th May; duration of illness, 4½ days. Left femoral bubo. Morphological, cultural, and inoculation tests positive.

Movements prior to Attack.—Had come to D. K. McLachlan's four or five weeks before attack, and had not been away from the premises since then.

History of Illness (from information supplied by his medical attendants).—Had been subject to attacks of vomiting, probably due to dyspepsia. 6th May: About 10 a.m. he was attacked with vomiting, and became ill. 9th May: He was sent by his employer to Grafton Hospital, where he was found to have a left femoral bubo about the size of a walnut, severe headache, and temperature 140°; Yersin's serum 40 c.c. was injected at noon, and the condition improved somewhat; temperature, 8 p.m., 102·5°. 10th May: Temperature—4 a.m. 101·5°, during the day about 103°; at 4 p.m. Yersin's serum 40 c.c. injected; bubo had increased in size; about midnight patient died. 11th May: *Post-mortem* examination; surface of trunk and extremities presented many petechial spots of dark purple colour; the bubo was an ovoid swelling about 3 inches long, and with patches of ecchymosis in its upper part; intestinal walls showed innumerable subserous hæmorrhages, varying in size from a pin's head to a filbert; spleen was enlarged.

Cultures from the liver, made at the autopsy, were examined in the Board's laboratory and found to contain *B. pestis*, this finding being confirmed by inoculation of a guinea-pig.

Residence.—The patient and a lad occupied a wooden hut, detached, about 50 yards from the main dwelling.

Rats.—Careful search of the premises was made by an experienced Sanitary Inspector on 12th May and succeeding days, but no signs of rat-burrows could be found, nor was there any history of dead rats on the premises. One live rat was seen, but escaped, and 6 dead mice, 4 of which were swollen and putrid, and the other two skeletons. Examination of the neighbourhood showed that rats were very scarce. Eighty premises were searched in the week 13th–20th May, but the total catch was only—rats, 21; mice, 44. These were forwarded to me at Lismore, and on examination showed no signs of disease. Previous to the occurrence of this case, the last plague-infected rat found in the district had been found on 8th March, at J. Long's premises, on the Grafton–Ulmarra Road, a quarter of a mile from this patient's place of residence.

Contacts and further Cases.—No further case occurred.

Places of Residence.—Of the 13 persons attacked, 12 belonged to 9 different households, and 1 was a carrier with no fixed abode. One household produced 3 cases (Cases B, E, and F); another produced 2 (Cases K and L). But, as regards the probable place of infection, it was possible to group some of the cases more closely. Thus, Case A was a frequent visitor to the house of Case D, and was known to have in fact visited there 2½ days before her attack, and to have sat in the barn, where at the same period many dead and sick rats were being found. At her own home there were no indications or history of dead or sick rats. It is reasonable, therefore, to connect Case A with the place of residence of Case D, rather than with her own home.

Again, Case C resided in a perfectly new cottage, some 6 miles out of Ulmarra township, and away from the other cases. He was, however, a frequent visitor at the house of Cases B, E, and F; visited there on 25th and 28th December, and was attacked on evening of 29th December. Here also it is reasonable to exculpate his particular place of residence, and to connect him with the home which produced three other cases at the same time and within a period of 4 days.

Beyond the relations here indicated no connection could be traced between the cases as regards their probable source of infection, and it seems justifiable to suppose that the places of infection for the 13 cases were 8 in number, of which 1 produced 4 cases, 2 produced 2 each, while the other 5 cases received the infection at 5 different and separate places.

The place of residence of each case is shown in the map attached. It will be noted that as regards the first six cases which, in regard to time, form a group, or rather two sub-groups, preceding the next cases by 19 days, the adjudged places of infection, two in number, are on the river bank, some 1½ and 3 miles respectively below Ulmarra. The next, Case G, occurred in the township; Case H, at Cowper, some 6 miles below Ulmarra, still on the river bank; Case J, in the township; Cases K and M, on the outskirts of the township; and Case N, on the river bank, 2 miles above Ulmarra; while Case L had no fixed abode, but had within 72 hours of his attack slept two nights at a barn, also on the river bank, about 1 mile below Ulmarra.

Relationship with infected Persons.—As already pointed out there is no reason to suppose that any case of plague had occurred in the district prior to Case A. This patient had not been away from the district, and, consequently, could not have had any relations with any other infected person. Similarly with regard to Case B. He had not been away from the district, and had not seen Case A subsequent to her attack. Moreover, she died on 17th December, 12 days prior to the date on which he was attacked. Case C had been a frequent visitor at the home of Case B, but his last visit was on 28th December, when they were both in good health, and he was attacked on the evening of the same day as Case B, namely, on 29th December. Case D, attacked on 30th December, had no relations with either of the two preceding cases subsequent to their attack, and though he had been on intimate terms with Case A, was not attacked till 13 days after her death, a period which dispels any suspicion of infection directly from her. Cases E and F lived in the same house as Case B, and were attacked 15 hours and 82 hours respectively after his attack. Here the question of personal contagion cannot be put out of court at once as in the other cases, but it is worthy of note that Case B, the first of these three cases, was of a particularly mild type, and, on that account, the less likely to be capable of infecting others.

Case G was attacked 17 days after the death of Case F. He had had no relations with any infected persons. At the date of his attack the only persons in the district who could be placed in this category were Case B, who was convalescent and back at his ordinary work, and Case D, who was an inmate of a hospital at South Grafton. Moreover, Case G had seen neither of these persons for at least 10 days.

Case H was a semi-invalid maiden lady who lived with an aged father and a niece, and never went further from home than to her next-door neighbour, or to church. She had had no relations with any previous case.

As regards Case J, attacked 23rd January, 1905, it is possible that he visited Case G between the time of his attack on 21st January and his removal to hospital on 22nd January.

Case K, a girl of 16, had had no relations with any previous case.

Case L equally had had no such relations.

Case M was attacked on 27th January, about 24 hours after his sister, Case L, but he had not seen her since 22nd January, when they were both in usual health, and he had no relations with any other case, having, in fact, been 28 miles away teaching at a school.

It is thus clear that in this outbreak personal contact was not a factor in spreading the disease.

Relationship with infected Rodents.—The epizootic of plague among the rodents is dealt with in Part III of this Report. The relationship of human cases to infected rodents has been fully described above in the account of the circumstances connected with the individual cases.

Incubation Period.—In one case (Case M) it was possible to fix the period of incubation at between a maximum of 6 and a minimum of 5 days. This patient came from a distant place where there was no suspicion of infection, to his parents' home, where it was found a few days subsequent to his visit that there was epizoötic plague among the rodents, and where Case K (his sister) resided. He arrived about noon on 21st January, and stayed till 2 p.m. on 22nd January, when he departed for the aforesaid distant place. Here he was in good health and performing his usual duties as a school-teacher until 27th January, on which date he woke feeling out of sorts, and by 10 a.m. was definitely ill with vomiting and other symptoms.

PART III.

PLAGUE IN RATS.

From 8th January to 10th March, 1905, the dates on which operations during the first outbreak at Ulmarra were begun and ended, rodents to the number of 2,683 were examined at Ulmarra for evidence of plague infection. The following table shows the number of rats and mice examined, and the number found infected, week by week from Ulmarra, Woodford Island (including Brushgrove), Grafton, and South Grafton. From neither of the two last-mentioned places were infected rodents obtained :—

Week ending	Ulmarra.				Woodford Island.				Southgate.		Grafton.		S. Grafton.	
	Examined.		Infected.		Examined.		Infected.		Examined.		Examined.		Examined.	
	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.
14 January ...	149	71	49	...	...	...	...	...	5	2	...	...	...	...
21 „ ...	45	2	...	...	8	...	...	...	51	...	34	15	2	...
28 „ ...	66	5	14	...	1	...	1	...	...	...	29	10	55	10
4 February ...	120	21	29	...	26	2	1	...	...	...	23	6	118	3
11 „ ...	176	69	2	2	63	15	3	1	...	...	33	7	2	3
18 „ ...	172	213	2	...	63	27	...	...	5	...	29	8	43	2
25 „ ...	206	95	4	...	37	4	...	...	...	...	37	10	2	...
4 March	121	47	...	...	55	7	...	...	...	...	31	13	1	...
11 „	73	33	1	...	...	...	...	...	5	...	18	16	3	...
	1,128	556	101	2	253	55	5	1	66	2	234	85	226	18

In addition to the rodents here tabulated, rats were examined from Laurence, 1; from Maclean, 1; from Harwood Island, 8; and from Woolgoolga, 50. From the first three of these places, which are situated on the Clarence River 6, 20, and 25 miles respectively below Ulmarra, none of the rats were found infected. Woolgoolga rats were, for convenience, examined at Ulmarra, but it is an entirely separate district, and is dealt with in another part of this report.

Of the conditions prevailing among the rats of the Ulmarra District prior to 8th January, nothing can with certainty be said, but from the information locally available, it appeared that rats had been unusually numerous some four to six weeks previously, *i.e.*, about the beginning of December, and that later on dead and sick rats had been seen at several places in the township and along the river bank. This mortality had been commented on, and had been loosely explained by the suggestion that the rats had been poisoned. I could not, however, hear of anyone who had actually laid poison at Ulmarra, and I learnt from the Mayor, who is also one of the principal storekeepers, that he had not sold more than two or three tins of rat poison in the past twelve months. So that there appeared little reason to suppose that poison had been used at all generally.

The rumour of rat mortality was not confined to the Ulmarra or right bank of the river. Similar statements were made with respect to the village of Southgate, on the left bank, opposite Ulmarra. Here a farmer named J. Donohoe stated to me that "before Christmas" he was overrun with rats. He laid some poison, but without much apparent effect. Between Christmas and New Year he began to find sick and dead rats. Easily killed the sick rats with a pitchfork. Picked up "some hundreds" of dead rats. The last dead rat found by him was found on 7th January, 1905. At my visit to the premises on 11th January, one dead mouse was found in an empty cottage and four dead rats in the barns, all, however, too far decomposed for bacteriological examination. During the following week 51 rats trapped in the neighbourhood of Southgate were examined, but none found infected, and no further mortality here was reported. The account given by Donohoe is strongly suggestive of an epizootic disease, but in the absence of direct bacteriological evidence, it is, perhaps, unsafe to say more than this. No human cases occurred at or were connected with Southgate, and no further rat mortality here or elsewhere on the left bank of the river was reported, with the exception that in May another farmer, H. McLachlan, residing on the left bank of the river some 4 miles above Southgate, reported that he had found dead mice at his farm, and submitted one of these for examination by me. The *post-mortem* appearances of this mouse were not, however, typical of plague, nor could conclusive bacteriological evidence be obtained. No further mortality among rats or mice here was reported.

In Ulmarra, the report of previous rat mortality was supported by the finding, on 9th and 10th January, of 50 rats and 65 mice mummified, in a barn at the residence of P.C. (Case D), and of 3 rats and 1 mouse in a similar condition at the place of residence of Cases B, E, and F. Under the existing climatic conditions—extremely hot, dry weather—this mummification would probably be produced in a week or ten days.

The second rat actually examined at Ulmarra was found to be plague-infected. This was on 8th January. The last infected rat was found on 8th March. In the 60 days thus delimited infected rats were found on 17 different premises in the municipality of Ulmarra, and on 3 premises in the adjoining village of Brushgrove, on Woodford Island. Plague infection was actually demonstrated in 106 rats and 3 mice. The infected rats were all of the *Decumanus* species. This is not contrary to previous experience in this State, but is, perhaps, worthy of mention, in view of the theory recently suggested (in *B. M. Journal* of 6/5/05) that *M. Decumanus* is naturally immune to plague. It should, however, also be stated that, of 1,128 rats examined at Ulmarra, 1,125 were *Decumanus* and 3 *Rattus*. On the other hand, of 234 rats from Grafton (where there were no cases nor infected rodents) 172 were *Decumanus* and 62 *Rattus*.

The number of demonstrably-infected rodents found on individual premises varied greatly. Thus, 10 premises furnished only 1 each, 1 furnished 2, 1 furnished 3, 3 furnished 4 each, 2 furnished 5, 1 furnished 6, and 2 premises 24 and 42 respectively. But, in most instances, the cleansing gang found also dead rodents which were too decomposed to permit of bacteriological diagnosis of the cause of death.

The following table is a list of the premises in which infected rodents, and 2 infected cats, were obtained, giving the number of infected rodents and also of rodents found dead, in which the cause of death could not be ascertained because they were too putrid. The order is the chronological order in which the premises were found to be infected :—

Week ending	Infected premises.	Infected rodents on such premises.	Other dead rodents.
14 January	Dr. Macky's, Ulmarra	Dec., 1	
	Brennan's "Exchange Hotel"	,, 42	Dec., 1
	P. Sullivan's, South Arm	,, 5	,, 2
21 ,,	None.		
28 ,,	Police Stables, Ulmarra	,, 5	,, 2
	T. Small's, ,,	,, 24	,, 1
	McMahon's Timber Yard	,, 4	,, 3
	W. Ensby's, Brushgrove	,, 1	
	Chinaman's Garden, Coldstream-road, Ulmarra.	Kitten, 1	
4 February	Hazzard's, Ulmarra	Dec., 3 ; Mus., 1	,, 4
	Mawhinney's, ,,	Dec., 6	,, 9
	O'Brien's, ,,	,, 1	
	C. E. Parsonage, Brushgrove	,, 1	
11 ,,	A. G. Bailey's, Ulmarra	Dec., 2 ; Mus., 1	Dec., 6 Mus.
	Daley's, Woodford Island	Cat, 1 ; Dec., 3 ; Mus., 1	Dec., 20
18 ,,	George Bailey's, Ulmarra	Dec., 1	Dec., 3 ; Mus., 3
	Northcote's, ,,	,, 1	Dec., 3
25 ,,	Joseph Bailey's, ,,	,, 1	,, 1
	J. T. Napper's, ,,	,, 2	,, 6
	Norman McLeod	,, 1	
4 March	None.		
11 ,,	J. Long	,, 1	,, 1

Origin of the Epizoötic.—Whence the *epizoötic* infection was introduced, and at what point in the district it first manifested itself can only be conjectured. As already described, Ulmarra has commercial relations with both Sydney and Brisbane—with the former by a regular semi-weekly service of steamers, in addition to occasional extra cargo boats, and with the latter by one weekly steamer. There is no overland trade. It is, therefore, necessary to examine the evidence of plague infection existing at Sydney and Brisbane about the time of the outbreak on the Clarence.

At Sydney plague-infected rodents had been obtained on 10th October, 1904, at 363, Sussex-street ; on 11th October, at Dalgety's Wharf ; on 4th November and 3rd December, at the A.U.S.N. Company's Wharf. After this last date, though the systematic rat examination was maintained, no more infected rats were brought in until 18th January, 1905, when 1 was obtained at the Sydney wharf of the North Coast Steam Navigation Company—the wharf, namely, at which the steamers from both the Clarence and Richmond rivers lie while discharging and loading cargo in Sydney. This was the first of 7 infected rats obtained from the same wharf on 18th, 19th, 23rd, 24th, and 25th January.

At Brisbane the official returns report finding of an infected rat on 8th October, 1904; but after this no more until 21st January, 1905, an interval of 105 days, during which, as far as is officially known, the town and port were free from plague in rats.

From this evidence as to known rat infection at the two places respectively—which, probably, however, cannot be accepted as fully and completely stating the actual conditions prevailing—and from the facts as to relative amounts of trade with Sydney and Brisbane, it would appear that the importation of infection from Sydney was more probable than from Brisbane.

The actual point or points at which the infection was introduced cannot be stated. The first human cases were associated with residences along the river bank between Ulmarra township and Cowper, a distance of 6 miles. The first evidence of mortality of rodents on a large scale was the finding of 50 rats and 65 mice mummified in Clarke's barn (Case D) situated on the river bank about 1½ miles below Ulmarra.

The first rat in which infection was demonstrated was found in Ulmarra on 8th January, 1905; but four days later, on 12th January, infected rats were found also in a cottage (P. Sullivan's), at South Arm, 7 miles below Ulmarra.

Thus there was evidence that by 12th January, 1905, rat plague had occurred along the river bank at Ulmarra, at South Arm, and at two intermediate places. There was as yet no evidence of its occurrence further away from the river bank.

The actual vehicle of the infection or infected rats could not be determined. Among the merchandise imported from Sydney were several kinds which might have served as a means of transporting rats, such as bales of empty bags and empty cases (egg and butter boxes). The imports from Brisbane were, generally speaking, of a less likely character.

The township of Ulmarra is served by the Ulmarra wharf which is used in common by both Sydney and Brisbane steamers. This wharf was also used by Clarke (Case D). The Plummers (Cases B, E, and F) and P. Sullivan, however, received their goods *viâ* the wharf at Brushgrove, a village at the western extremity of Woodford Island, where later on 3 premises were found infected.

The most probable theory as to the sequence of events appears to be that the infection was introduced at two points—Ulmarra and Brushgrove; that the epizootic spread first along the river bank, possibly because the rat population was more continuously distributed there than elsewhere; that it subsequently at Ulmarra spread through the township, and then from farm to farm in the immediate neighbourhood; that it manifested itself in a similar but to a much less degree at Brushgrove.

Special inquiry was made to determine whether the spread of infection was due to transported articles conveying infection or infected rats or to migration of the rats themselves. The evidence obtained, as well as the observed sequence of events, appeared to point conclusively to the latter. When once it had become known that plague-infected rats were being found in Ulmarra, a considerable amount of public alarm was caused, and every one was on the *qui vive* and fully alive to the necessity for preventing the importation to any premises of goods liable to convey rats. I could not learn that as regards any premises which were found infected any articles had recently been imported thither from other infected premises.

Migration was no doubt facilitated by the fact that nearly all the fields round the town were carrying a heavy crop of maize, which at that time was nearly ripe. These fields afforded shelter and also food, and through them there was for the rat an undisturbed path from one farm to another. At the same time they rendered hopeless any attempt to exterminate the rats by any measures short of destroying all the crops. The operations of the cleansing gangs were, therefore, confined to dealing with residences, barns, pigsties, and their immediate environment, destroying rats and their burrows, and as far as possible amending those conditions about the premises which afforded harbourage to rats.

These measures were vigorously carried out, and are described in more detail in Part IV of this Report. The epizootic appeared to gradually die down, the last infected rat was obtained on 8th March, and no further rat mortality was reported from any part of the district. Moreover, when some two months later search for rats was reinstituted in connection with another case of plague, it was found that rats were still exceedingly scarce.

The occurrence of rat plague at Brushgrove requires separate mention as this place is a village on Woodford Island, separated from the Ulmarra shore by the south arm of the Clarence—a navigable channel of considerable size. Communication with the right bank of the river is by punt from Brushgrove to Cowper. At Brushgrove is a public wharf used by the ocean steamers, and the neighbouring farmers on the mainland get their goods by this wharf as being more convenient than the Ulmarra wharf.

On 27th January, 1905, an infected rat was obtained from W. Ensby's residence in the village of Brushgrove. Prior to this there had been statements on good authority that dead rats had been found in the vicinity of the wharf. These were said to have been thrown into the river by persons who feared quarantine of their wharf. Ensby's residence is in the vicinity of the ocean steamers' wharf, and between this and the punt connecting with Cowper. Four days later another infected rat was found on Scott's premises in the same neighbourhood, rather nearer to the wharf. Systematic cleansing operations had meanwhile been instituted, and all rats obtainable submitted for examination. There were, however, no further indications of plague until 9th February, when two infected and seventeen putrid rats were found at Daley's farm, Woodford Island, about 1 mile from Brushgrove. Next day an infected rat and mouse and 3 putrid rats and an infected cat were obtained on the same premises. Daley had had no goods capable of transporting rats since six months ago, when he had some chaff from Sussex-street. I was, therefore, forced to conclude that the plague rats had reached his farm by migration. This was remarkable, as the country between his farm and Brushgrove was mostly open grazing land with some maize fields, and there had been no indications of infection at other places along the road.

The measures adopted here were the same as at Ulmarra. In all, 253 rats and 55 mice were examined without any further discovery of infection, and, besides these, many rats, probably hundreds, had been destroyed by the farmers, now thoroughly alive to the danger threatening them.

Plague in Animals other than Rats and Mice.—In view of observations recorded in other parts of the world as to susceptibility of domestic animals generally, the staff were instructed to investigate any information received which might bear on this question. Nowhere, however, was there any unusual sickness or mortality, with the exception that plague-infection was detected in 2 cats. One of these was a kitten found dead on 31st January at a Chinaman's residence in Ulmarra; the other a full-grown cat obtained on 10th February at Daley's farm, Brushgrove. This latter had been noticed to be sick and was killed for examination. In both these were found the changes usually characterising plague in cats, viz., enlargement of submaxillary glands, from which pure culture of *B. pestis* was obtained, and signs of general, but not acute, infection of other organs.

Part IV.

Administrative Measures.

The administrative measures adopted may be described under the following headings:—

1. Hospital accommodation and treatment.
2. The epizoötic. Operations for destruction of rats.
3. Quarantine measures for the protection of other parts of the District and of the State.

1. *Hospital Accommodation and Treatment.*

On my arrival in the district I found Case B convalescent, and needing no further hospital treatment, and Case D under treatment in a private hospital at South Grafton. As regards the latter patient, there seemed no necessity nor justification for removing him. Our Sydney experience had shown that the risk of infection from a patient suffering from bubonic plague is probably a negligible quantity, and this patient was under most satisfactory conditions as regards surroundings. It seemed advisable, however, to obtain the services of nurses who had had previous plague experience, not only on account of this patient, but because there was a probability of further cases occurring, and at my request two nurses were sent up by the Department and arrived on 9th January.

The next requisite was to find hospital accommodation for other cases that might occur. Ulmarra itself offered no prospects of a suitable establishment there. No suitable buildings were available, difficulties as regards medical attendance and necessary supplies appeared probable, and it seemed highly improper to establish a hospital in a district where epizootic plague was known to exist. Moreover, it seemed *primá facie* probable that if there were going to be an epidemic the majority of the cases would occur at Grafton, which is the largest centre of population, and, as the terminal port of the ocean steamers, more exposed to risks of infection than the down river towns, since the steamers lie two nights and a day at Grafton, whereas at the other wharves they merely call to discharge cargo and passengers.

There were several reasons against improvising a temporary hospital anywhere. One, that in such an institution, hastily organised, it would be difficult to provide as satisfactorily for the nursing and comfort of the patient as in a permanent hospital already staffed and in working order. Another reason against a temporary hospital was the probability that sporadic cases would continue to occur in the district for some time, and that it would be necessary on this account to maintain the hospital in an efficient state long after cases had ceased to occur. There was the further reason that it was eminently desirable, in view of the possibility of such sporadic cases in the future, that the medical and nursing staff of the District Hospital should be afforded an opportunity of familiarising themselves to some extent with the disease.

On these grounds it was decided ultimately that the best course would be to utilise the District Hospital situated at Grafton, and which is subsidised by the Government to serve the needs of Grafton and district, including Ulmarra.

This decision of the Department met, at first, with considerable opposition on the part of the Grafton public, amongst whom the outbreak of plague in the district had, not unnaturally, caused somewhat of a scare. However, the Department had the support of the medical profession of the district, and of the Hospital Committee, and after no great time the general public began to accept the assurance that the presence of plague patients in the hospital was no danger to the town, and to realise that the course pursued was right. The hospital is situated on the outskirts of the town, over a mile from the Post-office. It contains twenty-nine beds for general, medical, and surgical cases in the main building, and three beds in two wards in a small detached wooden building, some 100 yards from the other wards. This detached building was used for the plague cases, and also a small two-bed ward in the main building, which being on the ground floor, and approached only by a back verandah, was to this extent isolated from the rest of the wards. The nurses who attended the plague patients were not isolated in any way, but were quartered and had their meals with the rest of the nursing staff.

To supplement the accommodation at the hospital, a wooden ward, 40 feet x 20 feet, capable of accommodating five beds, was erected at the expense of the Department for £125 10s., and the Department sent up from Sydney beds, bedding, and other equipment for five patients and two nurses.

The staff of the hospital was also supplemented, at the expense of the Department, by four nurses who had had previous plague experience. The hospital being fortunate in the possession of a Matron (Nurse M. A. Coghlan) of exceptional tact and administrative capacity, these arrangements all worked with the utmost smoothness, and there was at the same time no hitch in carrying on as usual the ordinary business of the hospital.

For the medical care of the plague patients it was necessary to make a special arrangement, as the patients of some of the honorary medical staff objected, in the first scare, to the idea of sharing their medical attendant with a plague patient. Accordingly, Dr. Earl Page, who had already charge in his hospital of Case D, was appointed to this position.

2. *The Epizoötic—Operations for Destruction of Rats.*

The first work to be done on arrival at Ulmarra was the turning out and disinfection of premises occupied by previous plague patients. While this work was in progress, under the immediate supervision of the Department's Sanitary Inspector, rats were being examined from as many places as possible, and indications thus obtained as to where the cleansing operations should be continued.

An attempt was made, at the outset, to have the work done by the householders concerned, under skilled supervision; but soon it was found that progress was very slow with this arrangement, and it was considered better to engage a gang of labourers, who worked with two experienced gangers sent up by the Department on 30th January.

The plan of campaign adopted at first was to deal especially with premises found to be infected, and premises in the immediate neighbourhood of these. But when there developed indications of widespread and spreading infection, it was deemed advisable to work on a more comprehensive scheme. Accordingly, at my request, the Department sent up, on 6th February, two more gangers and eight labourers who had had previous experience in plague work.

With the local labour engaged, there were now available 4 gangers and 15 labourers, and these were disposed as follows:—1 ganger and 4 men at Brushgrove, to work thence along Woodford Island; 1 ganger and 4 men to work from the Coldstream River upstream to Ulmarra; a similar party to start from about 3 miles above Ulmarra, and work downstream to meet No. 2; and a fourth party, consisting of a ganger and 3 men, to work the premises more remote from the river bank.

In this way was effected a house-to-house visitation of all premises in the Municipality, except some lying far out in the south and south-west, which were considered to be fairly secure from infection by reason of their remoteness. On these also, however, much was eventually done by the farmers themselves to destroy rats and clean up generally.

The kind of work done by these gangs has already been described. In Ulmarra, 207 premises, out of a total in the Municipality of 291, were thus dealt with. On Woodford Island the operations were extended 8 miles down-stream from Brushgrove, and 108 premises in all were cleansed and searched for rats.

This work was brought to a close in Woodford Island on 4th March, and in Ulmarra a week later.

Measures adopted in other parts of the District.—While operations were in progress at Ulmarra considerable anxiety was naturally felt in the surrounding districts lest the epizoötic should spread there also.

Grafton

Grafton and South Grafton seemed especially likely places, as being much larger centres of population, and exposed to risks of importation of plague rats in a much greater degree than Ulmarra. Accordingly an experienced rat-catcher was detailed to trap in these two places, and his catch was forwarded once or twice daily to Ulmarra to be examined. From Grafton 234 rats and 85 mice, and from South Grafton 226 rats and 18 mice, were thus obtained, but none showed any signs of infection.

At the same time instructions were issued to the police in all the surrounding patrol districts to immediately report any unusual mortality among rats or mice. Several rumours of such mortality which reached us were promptly investigated by the police, but in none was there any justification for suspicion of plague.

One rat obtained from Laurence Post Office showed some suspicious bacilli, but it was partially putrid, and the examination was therefore unsatisfactory. No further rats could be obtained from this place.

The local authorities at Grafton and Maclean, above and below Ulmarra, were advised as to the kind of preventive action required, and took vigorous measures to clean up premises, remove accumulations of rubbish, and get rid of rats. At the same time a Departmental pamphlet of instructions was freely distributed to householders; and a proclamation by the Governor, calling on all persons to report any unusual mortality amongst rats, was displayed in all public places and published in the local press.

3. *Quarantine and Restriction of Trade.*

Prior to my arrival, and when a degree of panic prevailed locally on account of the outbreak, some quarantine had been imposed by the police authorities on the residences of the early cases. It was not, however, considered necessary to continue this, nor to adopt the same course with regard to other premises, with the exception of the "Exchange Hotel," at Ulmarra. Here plague rats were found on 11th January, and, as the place was dirty and rat-infested, it was decided that the general public, for their own protection, should be excluded until the cleansing operations were finished. The hotel was accordingly closed from 12th to 14th January, but the persons resident on the premises were not restrained in going in and out. The result of the work was the finding of 42 infected rats in the stables and outhouses, and the removal of many cartloads of rubbish.

Trade restrictions in regard to Ulmarra were imposed from 6th January, in terms of an Executive minute of that date, which authorised "Prevention of the transport by steamer of grain and fodder from Ulmarra, and from such places on the Clarence River as may hereafter be declared to be infected with bubonic plague, except when it is intended to bring such grain and fodder direct to Sydney or to take it outside the State."

Similar restrictions were extended to Woodford Island on the finding there of an infected rat on 27th January.

Maize being one of the principal products of the Ulmarra district, this prohibition was a serious matter for the farmers, whose crops were just ripening and ready to be gathered. However, an arrangement was made by which a cargo steamer was detailed by the North Coast Steam Navigation Company to serve the quarantined wharfs—Ulmarra, and subsequently Brushgrove—only, taking cargo from these direct to Sydney, where she lay in the stream and was unloaded into lighters; and on the 2nd February, 1905, the restrictions were modified to the extent of permitting the removal of grain only, under the above conditions, an addition being made to the instructions as follows:—"Fodder may not be removed within or out of the infected district under any circumstances." Meanwhile the other regular steamers ceased to call at Ulmarra, and any freight (other than fodder or grain) and passengers were conveyed from Ulmarra by a tender and transhipped at a plague-free wharf. It was not considered necessary to place any restrictions on the export of butter, which, being packed solidly in cubical boxes (1 foot each way), was not capable of carrying rats. This was of great importance, as the manufacture of butter is the staple industry of the district.

The restrictions were removed on completion of the cleansing operations, namely, as regards Woodford Island, excepting Brushgrove, on 28th February, 1905, and as regards Brushgrove and Ulmarra on 16th March, 1905.

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
PARISH OF ULMARRA, COUNTY OF CLARENCE.

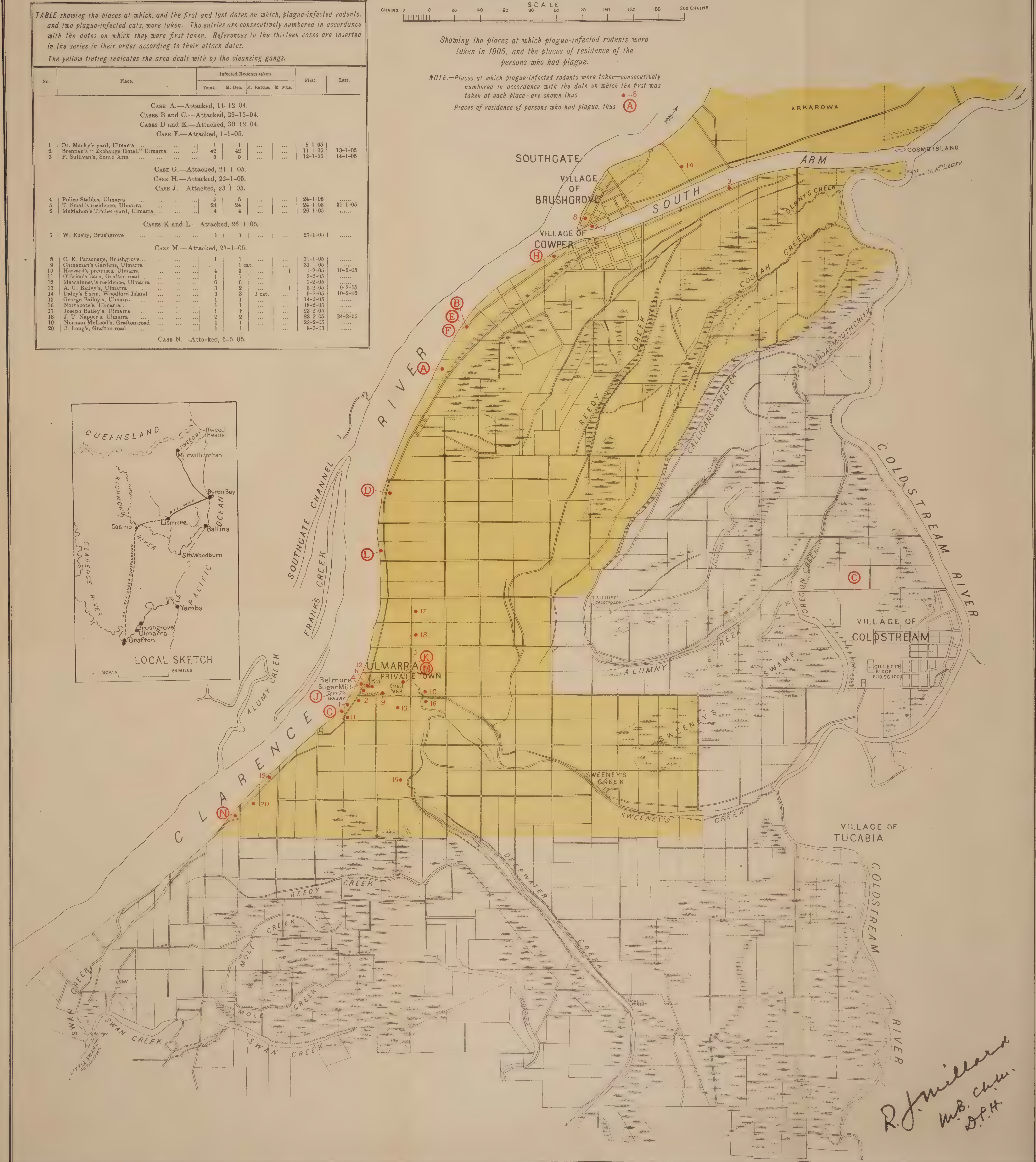
Showing the places at which plague-infected rodents were taken in 1905, and the places of residence of the persons who had plague.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ● 6
Places of residence of persons who had plague, thus Ⓐ

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents, and two plague-infected cats, were taken. The entries are consecutively numbered in accordance with the dates on which they were first taken. References to the thirteen cases are inserted in the series in their order according to their attack dates.

The yellow tinting indicates the area dealt with by the cleansing gangs.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus.	M Mus.		
	CASE A.—Attacked, 14-12-04.						
	CASES B and C.—Attacked, 29-12-04.						
	CASES D and E.—Attacked, 30-12-04.						
	CASE F.—Attacked, 1-1-05.						
1	Dr. Macky's yard, Ulmarra	1	1	...	...	8-1-05	......
2	Brennan's "Exchange Hotel," Ulmarra	42	42	...	...	11-1-05	13-1-05
3	P. Sullivan's, South Arm	5	5	...	...	12-1-05	14-1-05
	CASE G.—Attacked, 21-1-05.						
	CASE H.—Attacked, 22-1-05.						
	CASE J.—Attacked, 23-1-05.						
4	Police Stables, Ulmarra	5	5	...	...	24-1-05	......
5	T. Small's residence, Ulmarra	24	24	...	...	24-1-05	31-1-05
6	McMahon's Timber-yard, Ulmarra	4	4	...	...	26-1-05	......
	CASES K and L.—Attacked, 26-1-05.						
7	W. Eusby, Brushgrove	1	1	...	...	27-1-05	......
	CASE M.—Attacked, 27-1-05.						
8	C. E. Parsonage, Brushgrove...	1	1	...	...	31-1-05	......
9	Chinaman's Gardens, Ulmarra	...	1 cat.		...	31-1-05	......
10	Hazzard's premises, Ulmarra	4	3	...	1	1-2-05	10-2-05
11	O'Brien's Barn, Grafton-road...	1	1	...	...	3-2-05	......
12	Mawhinney's residence, Ulmarra	6	6	...	...	3-2-05	......
13	A. G. Bailey's, Ulmarra	3	2	...	1	5-2-05	9-2-05
14	Daley's Farm, Woodford Island	3	3	1 cat.	...	9-2-05	10-2-05
15	George Bailey's, Ulmarra	1	1	...	...	14-2-05	......
16	Northcote's, Ulmarra	1	1	...	...	18-2-05	......
17	Joseph Bailey's, Ulmarra	1	1	...	...	23-2-05	......
18	J. T. Napper's, Ulmarra	2	2	...	...	23-2-05	24-2-05
19	Norman McLeod's, Grafton-road	1	1	...	...	23-2-05	......
20	J. Long's, Grafton-road	1	1	...	...	8-3-05	......
	CASE N.—Attacked, 6-5-05.						



R. J. Millard
M.B. Ch.M.
D.P.H.

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

THE EPIZOÖTIC AT WOOLGOOLGA.

Woolgoolga is a small township of about fifty houses, situated on the sea-coast about 45 miles south of the entrance to the Clarence River and about 250 miles north of Sydney, and by road about 30 miles from South Grafton. The principal industry is timber getting, and there are two large saw-mills. There is no harbour, but a massive wooden jetty 500 yards long runs out from the beach. Vessels lie alongside but not in contact with this jetty, and goods and passengers are hoisted out by a steam crane. All trade is by sea. Four small steamers trade from Sydney (eastern side of Darling Harbour) to Newcastle, Coff's Harbour, Woolgoolga, Byron Bay, and the Tweed River every week, calling at Woolgoolga coming and going. There are no trade relations with the Clarence River. The exports from Woolgoolga consist chiefly of timber, with a small amount of farm produce. The imports are general stores and forage, together with empty egg cases and poultry coops. (N.B.—It was learned that not infrequently rats were landed in these returned empty cases.)

On 1st February, 1905, the Woolgoolga police reported to me at Ulmarra that a rat "had fallen from the roof of a cottage ceiling in Woolgoolga, had appeared sick, and died shortly after." By my request the specimen was forwarded to me for examination, and I received it on the 2nd February, some thirty hours after death. It was then already partly decomposed, and had been struck or crushed, with the result that the liver and spleen were smashed. Examination showed some hæmorrhages in the uninjured portions of the internal organs, and smears made from the spleen contained (among putrefactive organisms) numerous bacilli having the morphological and staining characteristics of the *B. pestis.* Cultures were made but were useless for diagnostic purposes as they became overgrown with putrefactive organisms.

The circumstances under which this rat had been obtained and the microscopical examination, indicated a necessity for further investigation, and accordingly a sanitary inspector and three rat-catchers were sent by the Department from Sydney for this purpose. I visited Woolgoolga on 6th February, and the rat-catching staff operated there 8–11th February, under the direction of the sanitary inspector, who forwarded the rats obtained to Ulmarra for examination.

The premises from which the first specimen had been obtained were situated about 300 yards from the jetty, and like most of the other premises in the neighbourhood of the jetty showed abundant signs of rat infestation. No other dead or sick rats, however, were found or heard of by the staff, and the total number of rats trapped or killed was only 49, including 5 from the abovementioned premises. None of these rats were found infected.

No cases among human beings were in any way connected with Woolgoolga.

It must be admitted that the evidence of the existence of the epizootic at Woolgoolga is meagre and unsatisfactory, and under these circumstances it is probably not worth while to discuss the possible sources whence the infection might have been introduced.

THE

THE OUTBREAK ON THE RICHMOND RIVER.

A. BALLINA.

PART I.

GENERAL DESCRIPTION OF BALLINA.

Ballina is the seaport at the mouth of the Richmond River, 331 miles north of Sydney, about 35 miles north of the mouth of the Clarence River, and about 70 miles south of Brisbane. On the Richmond River, many miles upstream, are situated the towns of Lismore, Casino, and Coraki, as well as the townships of Woodburn, Wardell, and many other smaller settlements.

The municipality of Ballina had at the Census of 1901 a population of 1,819, and contained 324 dwellings, of which it is recorded that 304 were of wood, and 209 contained five or more rooms. These figures are probably approximately correct at the present time.

The site of the town is almost uniformly flat, and little raised above sea level• The soil is sandy, and some areas formerly under water have been reclaimed by means of a sand-pump. Near the mouth of the river two arms join, the town being situated in the angle thus formed, and a canal has been cut from one arm to the other at the back of the town which is in this way surrounded on all sides by water.

Water supply is abundant and good, being led in pipes from a waterfall distant some miles out of town.

Sewerage there is none, with one exception, of importance in relation to the subject of this report. This exception is a storm-water drain about 8 chains in length, constructed of Monier pipes, about 3 feet in diameter at the outlet, which runs down Cherry-street to the harbour front. This takes surface waters from the street gutters, but also has connected to it the drains from Webster's Hotel (at the corner of Cherry and River streets), from an adjoining "Coffee Palace" in Cherry-street, and from Webster's-lane, which separates the "Coffee Palace" from Webster's stables in Cherry-street. The drains from Webster's Hotel and from the "Coffee Palace" are trapped, but that from the lane is not, and the inlet here is merely protected by an iron grating, the openings in which are sufficiently wide to permit the passage of a rat.

The town has a frontage to the river of about 1½ mile, which is composed of rough, loose stone-work. There are also extensive breakwaters and training-walls at the mouth of the river, constructed at great expense to improve the entrance, which is obstructed by a sandy bar. These are of the same rough, loose stone-work.

Trade, Industries, &c.—The town serves a large district, in which sugar-growing and dairying are the main industries. There is a large butter-factory and a large saw-mill on the river bank. Sugar-cane is taken to the Sugar Company's works, some 15 miles upstream.

Communication.—Ballina is connected by regular steamers with both Sydney and Brisbane. To the former, three steamers of the North Coast Steam Navigation Company run every week, in addition to fairly frequent extra cargo boats. With Brisbane and with the Clarence River, trade is connected with the s.s. "Pyrmont," which runs once a week to the Clarence River, and calls in at the Richmond River both going and returning. Besides these, there are some irregular traders, mostly timber-carriers. Local trade with places up the river is conducted by five or six small steamers, which ply up and down daily, carrying passengers and stores, as well as cream and other farm produce. The ocean boats above mentioned also go up the river, all of them to Coraki, 40 miles, and most of them to Lismore, 62 miles above the mouth of the river. Going and coming they lie at the Ballina wharves for varying periods, according to the cargo to be dealt with.

PART II.

PLAGUE IN MAN.

In all, 4 cases of plague occurred at Ballina, the attack dates being as follow:—

Case A.—Esther Nicholls, attacked 3rd February, 1905.
Case B.—John Day, attacked 22nd April, 1905.
Case C.—Elizabeth Wallbridge, attacked 2nd May, 1905.
Case D.—Mary Koorey, attacked 28th May, 1905.

Thus a period of 16 weeks was included between the date of the first and the date of the fourth attack, and the three intervals between successive cases were 11 weeks, 10 days, and 26 days. From the available information concerning the epizoötic, meagre though it is, it is probable that during the whole of this period of 16 weeks there were plague-infected rats in Ballina, and it is at least noteworthy that the cases should have been so few and chronologically so scattered. It should be added, too, that of these 4 cases, one (Case B) almost certainly received his infection, not in Ballina, but on a farm 5 miles out of town.

There was no reason to believe that any cases occurred other than those here described.

The circumstances surrounding the above-mentioned cases were in detail as follows:—

CASE A.—NICHOLLS, ESTHER.

Summary.—F., æt. 60 years, widow, domestic duties. No previous attack; never inoculated; no communication with any previous case. Residence, at her son's bakery in River-street. Attacked, 3rd February, 1905; notified by her medical attendant on 10th February; visited by me on 11th February; died, 14th February; duration of illness, 11 days. Right femoral bubo; morphological, cultural, and inoculation tests positive.

Movements before Attack.—Had not been away from Ballina for many weeks; spent most of her time at home doing small items of housework.

History of Illness.—3rd February—Having been previously in her ordinary fairly good health, on this date she vomited after doing a little washing, and had severe headache. 4th February—Seen in morning by her medical attendant, who found temperature between 101° and 102°. Admitted to Ballina Hospital about noon. Very dull; unable to give any account of herself, except that she had bad headache. Temperature at noon, 104°; at 4 p.m., 105·4°. After admission to hospital remained in a dull, semi-stuporous condition. Temperature each morning 102° to 103°, and each evening 103° to 104°. Tongue, at first creamy, became dry and brown. 9th February—Bubo first discovered as a small lump in right Scarpa's triangle, and extending above Poupart's ligament; slightly tender on palpation. No lesion on the drainage area of the glands involved was perceptible at that date. Fluid obtained by puncture of bubo with hypodermic needle showed numerous bipolar stained bacilli of same size and shape as *B. pestis*, and on cultural and inoculation tests with this fluid positive results were obtained. Temperature on 11th February was—in the morning 99·4°, and in the evening 100·4°. From this time the temperature kept down to about normal, and the mental condition became clearer; but she slept badly, and did not take her food well. 14th February—Became gradually weaker, and about 8 p.m. died. Autopsy, about eleven hours after death; rigor mortis well marked; no *post-mortem* lividity; no petechial hæmorrhages. Chest—Lungs healthy; some hypostatic congestion; no adhesions; heart walls thin and flabby; no valvular incompetence. Abdomen—Organs generally moderately loaded with fat; liver, fatty, not enlarged; spleen, normal in size, appearance, and consistence; kidneys showed evidence of old-standing chronic disease; cortex very much diminished; parenchyma generally pale and fibrosed; small ecchymoses under capsule. Bubo of the vertical group of inguinal glands.

Residence.—The premises comprised a shop and dwelling rooms, with bake-house at the rear, and a yard which extended past some hotel stables debouching on the harbour front at the point occupied by the Brisbane Wharf, *i.e.*, the wharf used by the s.s. "Pyrmont," trading to and from Brisbane. The buildings were of weatherboard, old, and in bad repair. In the bake-house the floor joists had rotted, and the floor planks were resting on the earth.

Rats.—Patient's son, the baker, occupying the premises, stated that he had found several dead rats about the place, the last, he believed, on 21st January (thirteen days before the alleged date of attack of this case). When these premises were turned out by the cleansing staff on 16th February, and later, abundant indications were found of previous rat infestation but no dead rats, nor could any rats be trapped here.

CASE B.—DAY, JOHN.

Summary.—Male, æt. 19 years, single, farm labourer and vendor of vegetables. No previous attack; never inoculated; no communication with any previous case. Residence and place of employment, John Kempnich's farm, about 5 miles north of Ballina. Attacked 22nd April, 1905; to hospital, 25th April; died, 28th April; duration of illness, 5½ days. Right inguinal bubo; morphological, cultural, and inoculation tests applied to bubo fluid with positive results. Blood from patient's ear, obtained twelve hours before death, was inoculated with fatal results into a guinea-pig, from which plague bacilli were then recovered.

Movements before Attack.—He was principally employed about Kempnich's farm, but went twice a week to Ballina to sell vegetables, and on the date of attack had spent the evening at Ballina.

History of Illness.—22nd April—While in Ballina spending Saturday evening he felt unwell about 10 p.m. and returned home. About midnight complained of aching in right leg and groin and of frontal headache; was feverish and chilly, and vomited. 23rd to 24th April—Worse; semi-unconscious at times. On 24th, about 8 p.m., seen by Dr. Corlis, who found temperature 102° and pulse 110, and glands of right groin enlarged and tender. 25th April—Removed to Ballina Hospital in morning; temperature in morning, 103°; evening, 104·6°; pulse, 120°; severe headache; bubo larger and more painful. 26th April—Temperature in morning, 102°; evening, 104·6°; pulse, 120; complaining of pain in abdomen. 27th April—Restless and delirious; temperature, 103·6°. 28th April—Morning temperature, 104·2°; pulse, 132; very feeble; about 8 a.m., died.

Residence and Place of Employment.—The premises were ill-constructed and ill-kept. The patient, with three other men, slept in a room under the same roof with and adjoining a stable, and a store-room in which paspalum grass seed, and maize and other forage were stored.

Rats.—Three dead rats had been found on the premises about two weeks before the patient was attacked, and, when cleansing operations were carried out on 27th April (5 days after the date of attack), 16 dead rats and 23 dead mice were found, and several more were killed. Of these, 2 rats and 3 mice were demonstrably plague-infected. The distance from Ballina, about 5 miles, made it unlikely that the infection had reached this farm by migration of rats; and it appeared more probable that infected rats had been transported from Ballina in bundles of sacks, empty cases, or such like. Kempnich sent fruit regularly to Ballina, and also considerable quantities of paspalum seed, the latter in sacks. Thus, in the course of his business, he received from the town empty cases and empty sacks; and it was learned that, as a matter of fact, he had received a consignment of fifty sacks from Nicholls' bakery during the week prior to the attack of Esther Nicholls (Case A) on 3rd February, 1905. Under these circumstances, there were ample facilities for the transport of rats from Ballina. Just when the epizootic at Kempnich's farm began is not indicated by the available evidence. Close questioning after the occurrence of the case elicited the information that three dead rats had been found about the beginning of April, and it is not improbable that the rat mortality may have begun very much earlier without attracting much attention from the farmer and his labourers, who would not appreciate its significance.

Case C.—Wallbridge, Elizabeth.

Summary.—Female, æt. 22 years, single, domestic servant; residence and employment, Commercial Bank, River-street, Ballina; no former attack; not inoculated; no communication with any previous case; attacked 2nd May, 1905; to hospital, 4th May; died, 9th May; duration of illness, 7 days; bubo, right axillary.

Movements before Attack.—She had not been away from Ballina for many weeks. Had gone about the town as usual.

History of Illness.—2nd May—The onset was sudden, with headache and pyrexia. 4th May—Developed a right axillary bubo, and, plague being then diagnosed, was removed to Ballina Hospital; here she made no improvement, the bubo increased, and the pyrexia continued. 9th May—Died.

Residence and Employment.—The Bank premises, a wooden building, were clean and well kept.

Rats.—No evidence of rat infestation was found on the Bank premises where she resided and was employed, nor had any dead rats been found there; but these premises are situated in a block in which plague-infected rats were found, both before and after the occurrence of this case. The back of the Bank premises abuts on Webster's-lane, only a few yards west of Webster's stables, where infected rats had been found on 14th and 15th February, and east of Martin and Williamson's produce store, in which infected rats were found on May 17th, a fortnight after her attack.

Case D.—Koorey, Mary.

Summary.—Female, æt. 21 years, wife of a small draper; employed at home in domestic duties; no previous attack; never inoculated; no communication with any previous case; resided on the shop premises in River-street, Ballina; attacked 28th May, 1905; diagnosed, 30th May, removed to hospital, 31st May; discharged, 23rd June; duration of illness, 26 days; right femoral bubo—morphological and cultural tests positive.

Movements before Attack.—Had been on a visit to Sydney, and returned thence on 21st May, 1905. Subsequent to return, was mainly occupied about her place of residence.

History of Illness.—28th May—First felt out of sorts, but was able to go for a Sunday afternoon walk. 29th May—In bed all day with headache; vomited during the day; at night felt pain in right femoral gland. 30th May—At 12·45 p.m. her medical attendant found temperature 105°, severe headache, and a definite right femoral bubo; seen by me at 5·15 p.m.; tongue moist and clean; complained most of headache; temperature, 104·4°; pulse, 126; diffuse swelling in right Scarpa's triangle, in which could be felt an enlarged and tender gland about the size of a small walnut; fluid obtained by puncture of this bubo contained abundant bipolar stained bacilli, and on Agar gave a pure culture of *B. pestis*; at 7·30 p.m. 60 c.c. of Yersin's serum were given; at 10 p.m. sleeping, with temperature of 103·6°; pulse, 106; respiration, 24. 31st May—Temperature, 103°; pulse, 120; bubo about the same; removed to hospital at 10 a.m.; vomited at intervals through the day; at 11·30 a.m. Yersin's serum 80 c.c. 1st June—Temperature, morning, 99°; evening, 100°; pulse, 90; bubo less tender and not so large. After this her progress towards recovery was uninterrupted, the temperature did not again rise above 100°, and the bubo gradually resolved without suppuration. 23rd June—Discharged from hospital cured.

Residence.—The draper's shop and the dwelling rooms behind it were clean, but built of wood, and situated next door to Martin and Williamson's produce store, with which they were structurally almost continuous.

Rats.—There were rat runs communicating freely between Martin and Williamson's produce store next door and the residence. On 17th May 4 plague-infected rats were found dead in the produce store; and on 19th May, during the cleansing operations instituted in consequence of this discovery, 1 more plague-infected rat was obtained. At the same date, the adjoining premises, including those occupied by the patient's husband, were searched for rats unsuccessfully, nor was any history of dead rats about Koorey's premises obtained either then or subsequently; but abundant traces of rats were found, especially above the ceilings in Koorey's and the adjoining premises, and the construction of the buildings, of wood and closely adjoining one another, was such as to permit of a free intercommunication of rats in this block. At the back of these buildings is Webster's-lane, which has already been mentioned as furnishing plague-infected rats earlier in the year.

N.B.—The clinical course of this case appears to strongly attest the value of Yersin's serum. At the outset the clinical and bacteriological evidence indicated that the case would probably be severe, and, if not fatal, at least accompanied by extensive necrosis in the bubo. Two doses of serum, 60 c.c. and 80 c.c. were given, after which the temperature fell, never to rise again, and the bubo gradually resolved without suppuration.

PART III.

PLAGUE IN RATS.

The first positive proof of epizoötic plague in Ballina was furnished on 14th February, 1905, when 6 dead rats were found at Webster's stables, of which 4 were demonstrably plague-infected, and the other 2 were putrid.

Prior to this the case of Mrs. Esther Nicholls (Case A) had occurred, and in connection with it information had been obtained that on the premises occupied by her, dead rats had been noticed about the middle of January. No reliable report of any other dead rats or mice could be obtained. The relation of Nicholl's bakery to the water front occupied by the Brisbane steamer wharf has already been described.

I have also drawn attention to the fact that the only sewer in the town was one running down Cherry-street past Webster's stables to the water front, and that Webster's lane was in direct communication with this sewer by a drain, untrapped and insufficiently protected against the entrance of rats.

After the discovery of plague rats at Webster's stables on 14th February, vigorous cleansing operations were undertaken at this spot with the result that on the next day, 15th February, 15 other dead rats were obtained, of which 8 were demonstrably infected, and 7 putrid. In the following two days, 3 other putrid rats were found in a bootshop in the same buildings, and 1 plague-infected cat in the Salvation Army Barracks adjoining.

These findings indicated that here was the principal focus of the epizootic, but at the same period, on 15th and 16th February respectively, plague-infected rats were obtained from the North Coast Steam Navigation Company's Wharf, and from Tattersall's Hotel. The wharf in question is only a few hundred yards west of the Brisbane Wharf, but the hotel is quite three-quarters of a mile away from Webster's stables. It seemed probable that infected rats had been transported to the hotel in forage or other goods, rather than that they were the result of migration, as there was no evidence of the epizootic on any of the premises lying between the hotel and the parts of the town known to be infected.

Forthwith on my arrival in Ballina on 11th February, in connection with Case A, I had begun the bacteriological examination of rats obtainable in the town. The Council engaged an experienced rat-catcher who brought his catch each morning for examination, and all citizens were exhorted to do the same with any dead rats or mice they might obtain. In this way 403 rats and mice were examined between 11th and 24th February; but in the last week of this period, not only were no plague-infected rats obtained, but rats of any kind had become so scarce that the rat-catcher's nightly takings, with 50 to 60 traps, amounted to only 3 or 4. This diminution in rats was probably due in part to the mortality and the scare caused by the epizootic, but also to the wholesale use of poison baits (phosphorus). On 16th February there was made a house to house distribution of these poison baits to all premises in the municipality, and this was followed by a marked diminution of the rat population, though not many poisoned rats were obtained. On 24th February, as the result of examination had been negative for a week, and, as it was desirable that I should return to the Clarence River (Ulmarra), my examination of Ballina rats came to an end.

Of the 403 rats and mice which were examined in this period, February 11th–24th, 16 were plague infected as demonstrated morphologically by smear preparations, and in most cases by culture also; 13 other rats found dead were too putrid for satisfactory examination.

The infected cat was brought to me as being sick, and was killed for the purpose of examination. It presented the lesions which appear to be common in plague-infected cats, namely, symmetrical submaxillary buboes which yielded pure cultures of *B. pestis*.

After February 17th there ensued an interval of six weeks until the finding of the next plague-infected rat on March 31st.

It is possible that dead rats were found during this interval and the finding concealed from the authorities, but it is certain that if there had been any considerable number the fact would have been divulged. Some suspicion attached to the circumstance that about March 27th, 2 dead rats were found in Webster's Hotel, but these rats are said to have been burnt by an ignorant employee, and were not examined.

On 31st March a plague infected rat was found dead at Dr. Corlis' stables, and on 5th April another in the same place. Smears from these rats were obtained by Dr. Corlis and by a laboratory assistant from this Department with considerable experience in this subject, who were agreed as to the infection. These stables are at the back of Dr. Corlis' residence in Crane-street, in a sparsely-occupied block to which no suspicion had hitherto attached, and which is well removed from any of the previously infected premises. Like most of the buildings in the town, this residence and the stables are of wood, but on examination by a Sanitary Inspector of this Department were found to show very slight signs of rat infestation; nor were the neighbouring premises rat infested. Forage for three or four horses had been obtained from a produce store in River-street, but a search of this store did not yield any results. One rat trapped in this produce store on 3rd April was uninfected.

A general reinspection of the business premises of the town was made at this time by the Sanitary Inspector above mentioned, who found them "fairly free of signs of rat infestation." Between 7th and 14th April, 30 rats were trapped and examined but all were found uninfected.

The next manifestation of the epizootic was at Kempnich's farm, 5 miles from Ballina, along the Bangalow-road. Here occurred Case B (John Day), and investigation occasioned by his illness resulted in the finding on 27th April to 1st May of 2 dead rats and 3 dead mice in which plague infection was demonstrated, and of 14 rats and 20 mice which were too decomposed for bacteriological examination. It was learned, also, that about two weeks before this 3 dead rats had been found.

On 2nd May there occurred Case C (Elizabeth Wallbridge), but no other infected rats were obtained until on 17th May 4 dead rats and on 19th May 1 other were found at Martin and Williamson's produce store in River-street. All these 5 rats proved on examination to be plague infected. These premises were used as auction rooms for the sale of produce and general merchandise. They were clean and well kept, but of wood, and open to the inroads of rats, whose track was traced from the adjoining premises under the tar-paved footpath. In the premises immediately adjoining, Case D (Mary Koorey) was attacked on 28th May.

Since 19th May no more plague infected rats have been heard of in Ballina, nor has there been any report of rat mortality.

Thus the epizöotic manifestations extended over the period 14th February to 19th May, 1905. This persistence, in spite of vigorous cleansing operations, may be attributed partly, I think, to the condition of the foreshore which, being faced with rough stones, provided ample shelter from which it was impracticable to entirely dislodge the rats, and partly to the fact of the houses being built of wood, with, of course, linings and double partitions, which greatly added to the difficulties of rat extermination.

Whence the plague rats were introduced to Ballina can only be conjectured, but it is at least very suggestive that the first case occurred on premises closely related to the wharf used by the Brisbane trader, the ss. "Pyrmont," and that Webster's stables, which appeared to be the important focus of the epizootic, were connected by an untrapped sewer with the foreshore near the same wharf.

The following table shows the place at which, and the first and last dates on which plague-infected rodents and a plague-infected cat were taken in Ballina and neighbourhood; the entries are numbered consecutively in accordance with the dates on which they were first taken. References to the four cases which occurred here are inserted in the series in their order according to their attack:—

No.	Place.	Infected Rodents Taken.				
		Total.	Rats.	Mice.	First.	Last.
	Case A, attacked 3/2/05—					
1	Webster's stables and Shop, Cherry-street	12	12	...	14/2/05	15/2/05
2	N.C.S.N. Co.'s Wharf...	1	1	...	15/2/05	......
3	Ainsworth's, Webster's-lane	1	1	...	16/2/05	......
4	Tattersall's Hotel	1	1	...	16/2/05	......
5	Salvation Army Barracks, Cherry-street	1 cat	...	...	17/2/05	......
6	Notley's store, River street	1	1	...	17/2/05	......
7	Dr. Corlis' stables	2	2	...	31/3/05	5/4/05
	Case B, attacked 22/4/05—					
8	Kempnich's farm	5	2	3	27/4/05	1/5/05
	Case C, attacked 2/5/05—					
9	Martin and Williamson's store, River-street ...	5	5	...	17/5/05	19/5/05
	Case D, attacked 28/5/05.					

PART IV.

ADMINISTRATIVE MEASURES.

The preventive measures adopted consisted of destruction of rats and cleansing of premises by the removal from back yards and from under houses of rubbish likely to harbour rats. This latter work was begun on 14th February, and was carried on by two gangs of men paid by this Department, and under the immediate supervision of a sanitary inspector of the Department.

At the same time, a rat-catcher employed by the Council set traps throughout the town, and each morning brought his catch to me for examination. From any rat presenting naked-eye appearances suggestive of plague, smears were made, stained, and microscopically examined forthwith, and, if necessary, agar cultures were made. Smears and cultures from plague-infected animals were subsequently forwarded to the Departmental Laboratory for confirmation of my diagnosis.

On 16th February the council, on my advice, made an organised house to house distribution of phosphorus baits, together with a handbill explaining how to use them. Altogether over 3,000 baits were distributed, in bags containing 6 each. At the same time, the Departmental pamphlet on plague prevention was distributed to all households.

The systematic cleansing operations were brought to a close on 25th February. When the later cases occurred, the local authority worked on the same lines.

As already stated, the patients were all removed to the Ballina Hospital for treatment. A separate ward was used, and nurses with previous experience of the disease were sent to Ballina by the Department. These nurses were not isolated from the rest of the staff.

B. South Woodburn.

The Epizoötic at South Woodburn.

South Woodburn is an unincorporated village of some 80 houses on the south bank of the Richmond River, about 40 miles by water above Ballina. It contains two hotels and several stores, and is a centre for the surrounding dairying district. It is a place of call for the ocean steamers as they pass up and down the river, is also in daily communication with Ballina and other smaller places below, and with Lismore, Coraki, and other places on the river above it, by small steamers which carry passengers and goods. Coaches conveying mails and passengers run frequently from South Woodburn to Chatsworth on the Clarence River.

The first intimation of the existence of plague-infected rats here was received from Mr. Veterinary Inspector McEachran, M.R.C.V.S., of this Department, who, in the course of his duty, was for the time being residing at South Woodburn. He reported on 18th March, 1905, that a dead and a sick rat had been found at Murray's Hotel, South Woodburn; that he had made post-mortem examinations, and found lesions suggestive of plague infection, and that he was forwarding specimens for examination in the Department's Laboratory. Two days later, on 20th March, another dead rat was found on the roof of the hotel, and specimens from this also were forwarded by Mr. McEachran. Cultural and inoculation tests in the Department's Laboratory showed that all three rats were plague-infected.

Accordingly, an experienced sanitary inspector, a laboratory assistant, and two rat-catchers were despatched by the Department from Sydney, and arrived at South Woodburn on 30th March.

Cleansing operations and the catching and examination of rats were at once instituted, and continued until 16th April. During this period 83 premises in South Woodburn, and 39 in the opposite village of North Woodburn, were dealt with, and examination was made of 249 rats and 80 mice.

Plague-infected rats were found on two premises only, namely, the two hotels. These are alike in construction, built of wood, and each containing 32 rooms, and stand on adjoining allotments in the main street, about 100 yards from the wharf. At Murray's Hotel, infected rats were obtained, as already stated, on March 18th and 20th, and during cleansing operations other 2 were found dead and putrid. At Priddle's Hotel, during cleansing operations on 1st April, 4 rats were found dead and putrid, and on 9th April, 2 other dead rats were found in an outhouse, one of which proved on examination to be plague-infected. On three other premises dead rats, 4, 1, and 2, respectively were found, but they were putrid and the cause of death could not be determined.

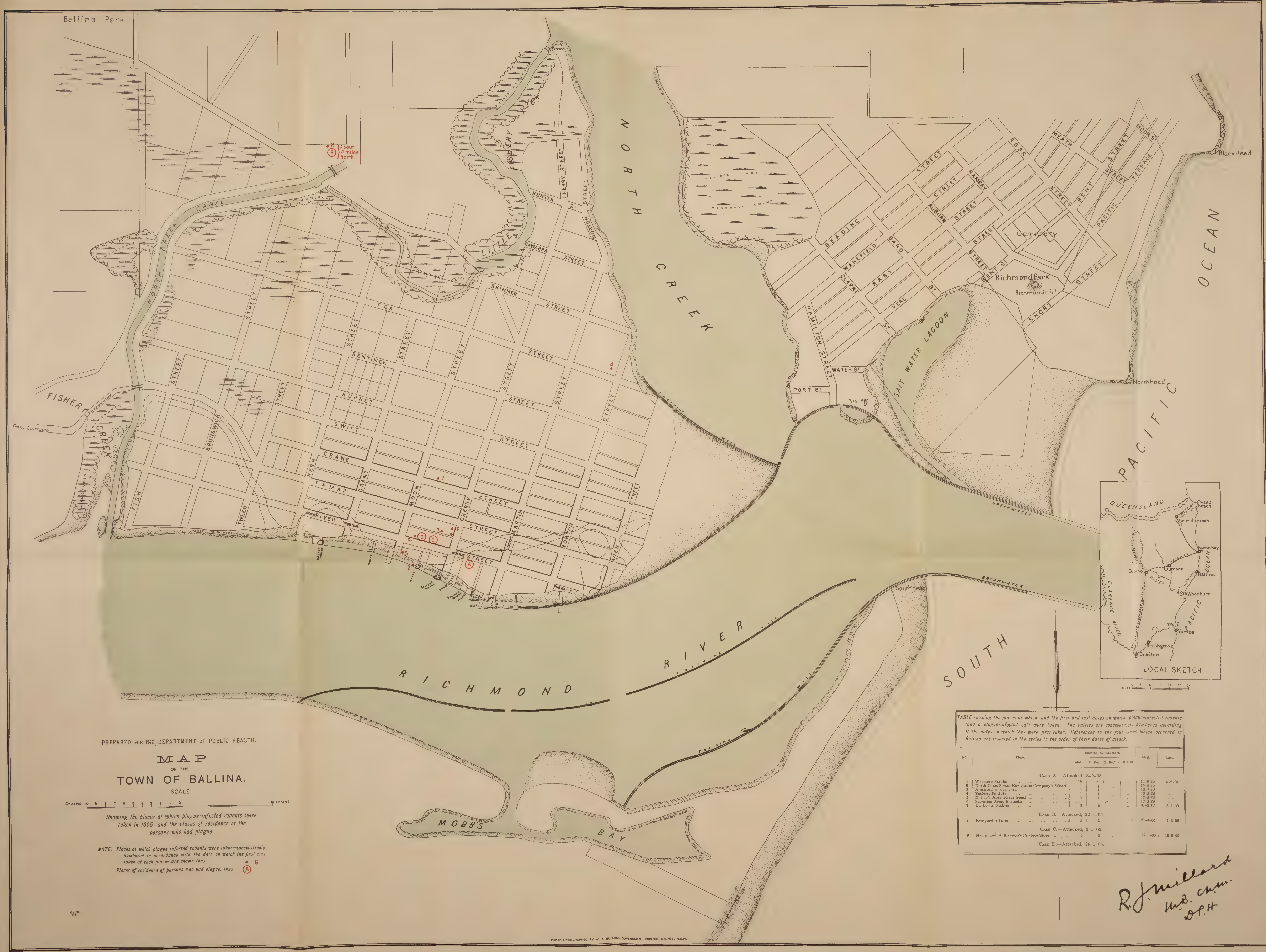
No information was obtainable of any previous mortality among the rats, but it was stated locally that about the middle of February the rats had suddenly disappeared from the wharf, which previously had been infested with them. Of the rats examined, a very large proportion, about 83 per cent. were found to be of the species *M. Rattus*, and the rest *M. Decumanus*; and it was observed that burrows indicating infestation by the latter species were comparatively rare.

On completion of the work already described, the staff returned to Sydney on April 18th.

No further indications of the epizootic were manifested until some six weeks later, when Mr. Davis, residing about half a mile from South Woodburn, found a dead rat under his dwelling on 28th May, and another on 29th May. The second rat was forwarded by the Police to Ballina, and on examination I found it to be plague-infected. Mr. Davis was instructed as to clearing his premises of rats, and no further mortality was reported.

The sequence of events at Woodburn, as far as can be conjectured from the meagre data available, was apparently that plague-infected rats were landed at the wharf by steamer, either from Ballina, or by an ocean steamer from Brisbane or Sydney. It should be noted that the daily river steamer from Ballina reaches South Woodburn in the afternoon, and lies at the wharf till next morning—a circumstance which would considerably facilitate the landing of rats. From the wharf the rats appear to have made their way to the two largest, and to them the most attractive, premises—the hotels. Thence, possibly as the result of the vigorous cleansing operations, they migrated, and their appearance half a mile away, at Mr. Davis', 6 weeks later, was probably the result of this migration. It is, however, possible that this later manifestation was the result of re-introduction of infected rats to Woodburn, as at that date (May 28th) there was epizootic plague at both Ballina and Lismore.

No cases occurred amongst human beings.



PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF BALLINA.

SCALE

CHAINS 10 9 8 7 6 5 4 3 2 1 0 10 CHAINS

Showing the places at which plague-infected rodents were taken in 1905, and the places of residence of the persons who had plague.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus •… 6

Places of residence of persons who had plague, thus Ⓐ

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents (and a plague-infected cat) were taken. The entries are consecutively numbered according to the dates on which they were first taken. References to the four cases which occurred in Ballina are inserted in the series in the order of their dates of attack.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus.	M Mus.		
	CASE A.—Attacked, 3-2-05.						
1	Webster's Stables	12	12	...	...	14-2-05	15-2-05
2	North Coast Steam Navigation Company's Wharf	1	1	...	...	15-2-05	......
3	Ainsworth's back yard	1	1	...	...	16-2-05	......
4	Tattersall's Hotel	1	1	...	...	16-2-05	......
5	Notley's Store (River front)	1	1	...	...	17-2-05	......
6	Salvation Army Barracks	...	1 cat.		...	17-2-05	......
7	Dr. Corlis' Stables	2	2	...	...	31-3-05	5-4-05
	CASE B.—Attacked, 22-4-05.						
8	Kempnich's Farm	5	2	...	3	27-4-05	1-5-05
	CASE C.—Attacked, 2-5-05.						
9	Martin and Williamson's Produce Store	5	5	...	...	17-5-05	19-5-05
	CASE D.—Attacked, 28-5-05.						

R. J. Millard
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PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

C. LISMORE.

PART I.

GENERAL DESCRIPTION OF LISMORE.

Lismore is situated on the north arm of the Richmond River, at the head of navigation, and is distant from Ballina about 21 miles by land and 62 by river, being thus 22 miles above Woodburn. The population at the last census, in 1901, was 4,378, and the dwellings inhabited 773, uninhabited 52. Owing to the lack of clay suitable for brickmaking, the buildings are almost universally of wood, 779 being so described at the census.

The area of the municipality is 14,061 acres, but a large portion of this is rural in character, and the business premises and many of the residences are concentrated in a few blocks on the flat land adjoining the river bank. This congested business area has as its northern boundary a watercourse known as Brown's Creek, which joins the river a short distance above the wharf principally used by the ocean-going steamers.

The town has lately been sewered, and the house connections were being made at the time of this plague outbreak. Previously there were no sewers, and, for the conveyance of slop and surface waters, recourse was had to some badly-constructed and dilapidated box drains, of which the principal one still exists, and leads from the centre of the main business block, under Woodlark-street, to discharge on the bank of Brown's Creek.

There are no cesspits in the town. Pail closets are in general use.

The regular removal of house refuse, rubbish, and garbage has not been enforced by the Council, and in consequence most premises were found encumbered with accumulations of these matters. This was especially the case on the premises backing on Brown's Creek, which appears to have been regarded as a legitimate tip.

Products, Communications, &c.—Lismore is the centre of a rich and important district, in which dairy-farming and sugar-growing are the chief industries. Butter is the principal article of export, but the imports include general merchandise of every description.

There is railway communication with Murwillumbah, on the Tweed River (61 miles), and with Casino (18 miles); but by far the greater part of the trade is carried by water. Every week two steamers from Sydney and one from Brisbane come regularly to Lismore, which is their terminal port after they have called at Ballina, Woodburn, Coraki, and other places on the river below Lismore. These steamers generally remain at Lismore two or three nights while they unload and reload for the return voyage. Other occasional ocean boats come with special cargoes, as of coal from Newcastle. Besides these there are several regular river steamers plying regularly between Lismore and Woodburn, and calling at all wharves to collect or put off passengers and freight. The freight is mainly cream for the butter factories, but includes general stores also.

PART II.

PLAGUE IN MAN.

The first recognised case of Plague at Lismore was that of George Elliott, aged 26 years, an assistant draper in McDermott's general store. He was attacked on the afternoon of the 1st May, and died five days later.

It is not, however, certain that this was the first case that occurred. Three deaths, one in March, and two in April, had been certified as due to dengue fever. This disease is seldom fatal, and in discussing these cases with their medical attendants, I learned that their symptoms were not typical of dengue, and that in the light of subsequent occurrences, plague could not be absolutely excluded.

At the same time, however, there was widespread epidemic of dengue in Brisbane, and several other cases are said to have occurred in Lismore. As regards the fatal cases above mentioned, it was stated that there was enlargement of glands, but in none was a bubo a sufficiently prominent feature to arrest attention and suggest at the time the diagnosis of plague.

Another case to which my attention was called by the medical attendant was that of Miss G. S., aged 25 years, domestic duties, whose history was that, on 26th April, 1905, she was taken ill with severe pain in the right axilla, pyrexia, and severe headache. She remained in bed, and on 29th April sent for her doctor, who found temperature 102 degrees, and a tender axillary swelling. Her symptoms soon abated, however, and after seven or eight days in bed she was able to resume her household occupations, feeling somewhat weak, but otherwise unaffected. The axillary swelling was slow in disappearing, and when seen by me, on 16th May, she had a deeply-seated axillary bubo rather smaller than a walnut, and not tender. On puncture some clear fluid was obtained, but nothing grew from this when sown on an agar. This may have been a mild case of plague, but it is more usual for an axillary plague to be accompanied with severe symptoms. This patient has not been away from Lismore for many weeks.

The facts concerning the eight cases reported and diagnosed as plague are as follow:—

CASE A.—ELLIOTT, GEORGE.

Summary.—Male, æt. 26 years, unmarried, draper's assistant. No former attack; not inoculated; no known communication with any previous case. Residence, Kean-street, Lismore, about half a mile north of his place of employment, which was at McDermott's general store, Woodlark-street; had not been away from Lismore for many weeks prior to attack. Attacked 1st May; died 6th May; bubo, left femoral; morphological tests positive.

History of illness.—1st May—After being at work as usual all day in his usual health, he was at 5 p.m. suddenly attacked with shivering and vomiting, and developed severe headache. 2nd May—Seen by his medical attendant, and sent to a private hospital during the morning; temperature then, 105°. 3rd and 4th May—Very ill, semi-delirious; plague being suspected, bubo was sought for, but without success. 5th May—In the morning his medical attendant found definite left femoral bubo "as large as a pigeon's egg," and extremely tender. In the afternoon of the same day he was seen in consultation with Dr. Corlis, of Ballina, who made smears from fluid obtained by puncture of the bubo; these smears contained numerous bacilli morphologically identical with *B. pestis*. 6th May—After a somewhat restless night, he died very suddenly about 7 a.m.

Residence.—A wooden cottage, clean, and in fairly good repair.

Employment.—A large general store in Woodlark-street, built of weatherboard and galvanized iron. In the main store was a large stock of general goods, and at the back, in another building, bulk goods and farm produce were stored. Between these was a lane giving access to the backs of the shops, &c., in the block, and from this lane a box drain ran under Woodlark-street to discharge on the bank of Brown's Creek. This box drain had several inlets in and about the lane, most of them being by gulleys of defective character.

Rats.—At residence, few or none. None obtainable for examination. At place of employment, on 22nd April, 19 dead rats had been found in the ironmongery department, and on 25th April—when the shop was opened after the Easter holidays, 2 or 3 more, one of these last being behind a roll of calico in the drapery department, where this patient worked. Poison had been laid in February and March but not since. The store was thoroughly turned out on 9th to 11th May by a cleansing gang under two experienced foremen despatched by the Department. No other dead rats were found.

CASE B.—TONKIN, AMY JANE.

Summary.—Wife of dairyman, æt. 35 years. No previous attack; not inoculated; no communication with any previous case. Resided on her husband's dairy farm about 3 miles out of Lismore. Comes to town frequently. Prior to her illness was last in town on 28th April, when she visited McDermott's general store (*vide* Case A) amongst other places. Remained in town from noon till 2·30 p.m. Did not stable her horse, but tied up in the street. Attacked, 1st May; to hospital, 7th May; discharged, 22nd May. Bubo, right inguinal.

History of Illness.—1st May—Felt out of sorts in afternoon, and could hardly do her milking; was heavy and weak with headache. 2nd May—Worse; milked 4 cows in the morning, then had to cease work; had an attack of shivering. 3rd May—Observed a lump in right groin, which was very tender. 4th May—Feeling very bad, but dragging herself about. 7th May—Consulted her medical attendant, who found temperature 102·4°; tongue brown. Sent to hospital, where she was collapsed with sub-normal temperature. 10th May—When seen by me her temperature and pulse were normal, but there was still a right inguinal bubo about the size of a pigeon's egg, not very tender on palpation. Fluid obtained by puncture of this bubo showed no bacilli in smear, nor did it produce any growth when sown on agar. The subsequent course of the case was uneventful. The bubo grew gradually smaller, and she was discharged from hospital convalescent on 22nd May.

Residence.—A four-roomed cottage, 3 miles out of Lismore, built on a slope, and with the front resting on piles. No indication of infestation by rats, and no history of any dead or sick rats about the house or the dairy farm. No produce nor other goods likely to carry rats had been obtained from town.

Rats.—As above stated, patient had been shopping at McDermott's store in Lismore on 28th April, and had been looking at goods in the drapery department, where at least 1 dead rat had been found on 25th April, and where Elliott (Case A) was working when taken ill on 1st May.

N.B.—Cases A and B were attacked on the same day (1st May) and both in the afternoon.

CASE C.—SKIDMORE, EPHRAIM FRANCIS.

Summary.—Married, æt. 41 years. In charge of ironmongery department at McDermott's store. No previous attack; not inoculated. Had worked in same store as Case A, and had possibly served Case B on 28th April, but had had no communication with either case subsequent to 1st May, when they were attacked. Attacked, 3rd May; to hospital, 7th May; discharged, 23rd May. Bubo, left femoral. Resided in Keen-street, about half a mile south of place of employment.

Movements prior to Attack.—Had not been away from Lismore for many weeks, but had been every day employed at McDermott's store.

History of Illness.—3rd May—After working as usual in the morning, going out for his Wednesday half-holiday, and eating a good tea, he was suddenly attacked about 8 p.m. Had rigor and vomiting, which lasted half an hour, and severe headache all night. Did not sleep. 4th May—Seen by his medical attendant about noon. Temperature, 103·8°; tongue coated; pains in back; and severe headache. At night had some pain in upper and inner part of left thigh as if he had strained the muscles. Had a restless night. 5th May—About the same. 6th May—Inflamed gland (left femoral) now observed; temperature, 102·6°; headache still. 7th May—Admitted to hospital; temperature, 101°; pulse, 84. 10th May—First seen by me; temperature was now normal, but there was a left femoral bubo about the size of a walnut, and also an enlarged deep inguinal gland on the same side; both could be palpated without causing much pain; fluid obtained on this date by puncture of bubo was examined for bacilli by smear and culture, but with negative result; his subsequent course was uneventful; the temperature remained normal, except for one slight rise due to another cause than plague; the enlarged glands remained indolent. 23rd May—Discharged convalescent to his own home, when the bubo eventually suppurated.

Residence.—A wooden cottage, clean and well kept.

Employment.—*Vide* under Case A.

Rats.—*Vide* Case A. The first search, which discovered 19 dead rats on 22nd April, was made by this patient in consequence of bad smells in his department of the shop.

CASE D.—MULLINS, JAMES.

Summary.—Æt. 22 years. Employed in McDermott's store as assistant to Skidmore (Case C) in the ironmongery department; resided in lodgings in Little Keen street, about half a mile away. No previous attack; not inoculated; fell ill six days after Elliott (Case A), and four days after Skidmore (Case C), both fellow employees, but probably had no communication with either of these patients after they became ill. Attacked, 7th May; to hospital, 12th May; died 16th May; duration of illness, nine days; no bubo; plague pneumonia or pneumonic plague; morphological and cultural tests positive.

Movements before Attack.—Had not been away from Lismore for many weeks. Employed all day in the store.

History of Illness.—7th May (Sunday)—On waking had headache and pains all over him. 8th May—Unable to go to work, but did not keep to his bed. 12th May—As he did not improve, he called in his medical attendant, who sent him to the hospital to a private ward. By request of his medical attendant, I saw him soon after admission. His temperature then was 102·6°, and his tongue inclined to be dry. His only complaint was of general pains all over; no indication of any bubo could be found anywhere. The abdomen was somewhat full, and there was some tenderness on deep pressure of the right iliac fossa, also the spleen was enlarged. 13th May—Temperature ranged between 101° and 102·8° for a good part of the day. He was semi-delirious, talking nonsense, but remembering afterwards what he had said and done. At night he complained of severe pain in the back. 14th May—Temperature, 103° at 4 a.m., fell to 100° at 4 p.m.; pulse about 112; respiration in evening, 44; no cough; no sputum, and, on examination by his medical attendant, no physical sign of pneumonia; still delirious at night, complaining greatly of pain, but unable to locate it, except sometimes in the small of the back. 15th May—Temperature, 4 a.m., 102°; 8 a.m., 99·2°; 12 (noon), 102·6°; 4 p.m., 104°; pulse and respiration at 4 p.m., 134 and 48; his medical attendant prescribed baths, and he had three, at 4 p.m., at midnight, and 4 a.m.; in spite of these, the temperature remained up at nearly 104°; death took place at 9·40 a.m. on 16th May; *post mortem* examination 2·30 p.m.; lividity of dependent parts well marked; no bubo or external swelling.

Chest.—Pericardium contained a large quantity of fluid; no pericarditis; no subserous hæmorrhages; heart fairly normal.

Lungs.—Both showed scattered dark hæmorrhagic patches, which were solidified to touch; the posterior parts of both showed livid consolidation; the condition amounted to a scattered lobular pneumonia.

Abdomen.—The liver, spleen, and kidneys were all enlarged, but specially the liver, which was besides abnormally yellow. The intestines showed some general congestion of the vessels, and this appeared in places to be accentuated in the region of a Peyer's patch; the mesenteric glands were normal in size and appearance; the inguinal glands were quite discrete, but appeared slightly larger than normal, so were removed for examination. Smears were made direct from spleen, liver, and right lung (a hæmorrhagic patch), and cultures from spleen, liver, right kidney, right lung, and heart blood. The following were removed and preserved in spirit:—Inguinal glands (right and left), portions of spleen, liver, right kidney, a Peyer's patch, and a portion of right lung. Immediate examination of smears gave the following result:—Lung—Masses of bacilli morphologically same as *Pestis*, decolourised by Gram's method. Cultures gave the following result:—

Right kidney	No growth.
Spleen	Positive for *Pestis*.
Liver	No growth.
Heart's blood	No growth.
Right lung	Original culture, mixed growths; sub-culture, positive for *Pestis*.

Residence.—A wooden cottage, cleanly kept, and in good repair.

Employment.—McDermott's store (*vide supra*).

Rats (*vide supra*).—Nineteen dead rats were found in the store on 22nd April, and more on 25th April, and during the cleansing operations other dead rats were found at the rear of the store on 9th and 10th May. From this it appears that the mortality among rats in the immediate neighbourhood of the store continued over the probable date of infection of this patient.

CASE E.—CONNELL, DANIEL.

Summary.—Æt. about 65 years; did odd jobs, as watchmaker, umbrella-mender, &c. No previous attack; not inoculated; no known communication with any previous case. Resided at McCormack's Hotel, North Lismore. Attacked, 7th May; died, 9th May; duration of illness, thirty hours; bubo, right femoral.

Movements prior to Attack.—He had not been away from Lismore; but in looking for work he probably frequented various parts of the town.

History of Illness.—He is said to have been intemperate, and not robust, but was apparently in his usual health until the evening of 7th May. 7th May—On this evening the stableman at the hotel heard him call out, and on going to his assistance found him lying on the ground "as if he had had a fit"; he helped him back to his room, Connell being unable to walk; the old man complained of no definite symptoms, but seemingly was in a state of collapse. 8th May—Taken in a cab to the Lismore Hospital, and admitted about 11 a.m.; on admission he was delirious, and could give no account of himself; he appeared to have severe pain in right lower limb; had a femoral bubo, and also some swelling at right knee—possibly a popliteal bubo; the tongue showed furred edges, and a dry, cracked central strip; pulse was very bad; body surface was generally mottled, and also showed numerous petechiæ, small at first, but later of larger size. 9th May—He never rallied, but died about 2 a.m., the total duration of illness having been about thirty hours from the onset of symptons to the fatal termination.

Residence.—The room which he occupied at the hotel was part of the stables, had an earthen floor, and communicated with the stalls. The furniture was of the poorest description, and the room contained much filthy rubbish. These stables are about 30 yards from the hotel. The hotel is a weatherboard two-storied building, on a site which falls away from the street front. Under the ground floor, and opening towards the stable, are feed-room, groom's room, wash-house, and unoccupied space. The hotel stands on a point of land between two arms of the river, and close to the river bank, and to the bridge which crosses from this point to the centre of the main town (South Lismore).

Rats.—The licensee said he had at times found dead rats about the place, the last having been found in the wash-house about the time that Connell was attacked. These rats were destroyed as found, without any examination, but had probably died of disease, as no poison had recently been laid. The structure of the house is such as to afford shelter to rats, and its position, close to the river-bank, makes it a likely resort. During cleansing operations in the town, traps were repeatedly set here, but without result. Any rats that had previously infested the place had, for some reason or other, scattered elsewhere.

CASE F.—ANDERSON, CECIL.

Summary.—Schoolboy, æt. 12 years. No previous attack; not inoculated; no communication with any other case. Residing with parents at Orion-street. Attacked on 9th May; notified on 10th May, at 2 p.m., and visited by me at once; removed to Lismore Hospital same day, at 3·30 p.m.; discharged 31st May; duration of illness, 22 days; right femoral bubo; bacteriological examination negative.

Movements before Attack.—Had not been away from Lismore for many weeks. On 8th May, in morning and afternoon, had been watching cleansing operations behind McDermott's store. (*Vide* Cases A, B, C.)

History of Illness.—9th May—About 6 p.m, complained of a painful lump in right groin; but, later, played about in the street. 10th May—Woke with severe headache, was dizzy and unable to stand; seen by his medical attendant at 10·30 a.m., when he had temperature 103°, and definite bubo in right groin. When seen by me at 2·45 p.m., had temperature 105°; pulse, 150; large very tender swelling in right Scarpa's triangle, and some tenderness above Poupart's ligament; lips were dry, tongue coated but moist; was drowsy and unable to give account of himself; on admission to hospital temperature was still 105°, and the same at midnight, when he had a rigor. 11th May—Better; temperature, 104° at 4 a.m., 100·4° at midnight. 12th May—Had a good night, and this morning temperature normal; still somewhat drowsy, and there is some painful enlargement of a left cervical gland. 13th May—Better; tongue cleaning, and temperature keeping down; swelling of neck subsided with use of fomentations; femoral bubo still large and tender; subsequent course was uncomplicated; the bubo suppurated, and was opened on 23rd May. 31st May—Discharged cured.

Residence.—A wooden cottage of rather poor description, but clean, and showing no sign of rat infestation.

Rats.—None at residence, but many dead rats had been found in and about McDermott's store, in the vicinity of which he was for several hours on the day before his attack.

CASE G.—DUFFY, FRANCIS.

Summary.—Æt. 25 years; foreman employed in cleansing gang. No previous attack; not inoculated; no communication with any previous case. Attacked on 11th May; reported sick on 12th May, 7 a.m.; removed to hospital at once same day; discharged 31st May; duration of illness, 19 days; right inguinal bubo; morphological and cultural tests positive.

Movements before Attack.—Left Sydney by steamer on 6th May, and arrived at Lismore on the afternoon of 8th May. Began work of cleansing McDermott's store on 9th May. Finished this work on the 10th, and worked in block at back of store on 11th May.

History of Illness.—11th May—About noon, while at work, noticed that a right inguinal gland was somewhat enlarged and slightly tender; finished his day's work, and at night was restless, talking in his sleep. 12th May—In morning felt weak, had pains in both legs and back, and an acutely tender right inguinal gland about the size of a marble; admitted to hospital at 8 a.m.; temperature at 8 a.m., subnormal; at 8 p.m., 102·8°; at 2·30 p.m. on same day had 60 c.c. Yersin serum hypodermically. 13th May—Had a good night; temperature, 8 a.m., 102·6°; 8 p.m., 100·5°; bubo very tender, but no larger. 14th May—Temperature, 8 a.m., 99·2°; 8 p.m., 98·2°. 15th and 16th May—Temperature normal. 19th May—Slight urticaria began to show itself round the point of serum injection (performed on 12th May); following this urticaria there ensued severe joint pains, affecting especially elbows, right thumb, ankles, and toes; at the same time the temperature gradually rose, and on 23rd was 102° at 8 a.m.; at the same time the bubo was gradually diminishing; after the 23rd the pains subsided, and a week later he was able to be on the verandah on a couch. 31st May—He was discharged convalescent. N.B.—This case presents several important points of interest: *The incubation period* of the disease was apparently under three days, as patient did not reach Lismore till the afternoon of the 8th, and felt the first symptoms at about noon on the 11th; *the mildness of the case*, though associated with an undoubted infection with the *B. pestis*; *the two effects of serum injection*; the rapid improvement in symptoms, followed seven days after the injection by urticaria, severe joint pains, and pyrexia.

Residence.—At the time of attack he was lodging at an hotel in Molesworth street, which was clea and not under suspicion as infected, either then or subsequently.

Employment.—*Vide supra.*

Rats.—At residence, none. During cleansing operations at back of McDermott's store, several de rats were found on 9th, but as I had not then arrived in Lismore, they were destroyed without examinatio.

CASE H.—STAPLEFORD, PETER.

Summary.—Æt 22 years, single; store assistant; resides in Keen-street (between James and Parke Streets), about half a mile from his place of employment, which was at Robertson's "Red Flag" store Molesworth-street. No former attack; not inoculated; no communication with any previous case Attacked 30th May. Notified by his medical attendant on same day at 1 p.m., and visited by me at once Removed to hospital on 31st May; discharged on 22nd June; duration of illness, 24 days. Bubo left femoral; morphological and cultural tests of fluid from bubo and from vesicle on leg, both positive.

Movements before attack.—Had not been away from Lismore for many weeks. Occupied in the store all day; at home in the evening.

History of Illness.—Up to 30th May was in his ordinary health. On this morning he noticed when dressing that he had some pain in upper and inner part of left thigh. Went to work as usual, but about 9 a.m. began to shiver and feel ill, and about 10 a.m. ceased work and went to see his medical attendant, who found temperature 101·4°, and a slightly enlarged and tender femoral gland. By the doctor's instructions he went home and to bed. Seen by me at 1·30 p.m. He had temperature of 103·2°, pulse, 126. Tongue moist and clean. A left femoral gland was enlarged to about the size of a small almond, but not markedly tender. Leading to the gland was a faint track of lymphangitis, which started from a small semi-pustular vesicle on the outer side of the upper third of the leg. This line of lymphangitis crossed below the knee-cap and ran up the inner side of the knee. Patient stated that he had noticed this first when he was going to bed after seeing his medical attendant, his attention being drawn to it by pain on the inner side of the knee. Smears made from the fluid in the vesicle showed scanty bacilli resembling *B. pestis*, and cultures from the same fluid subsequently established their identity. Yersin's serum 60 c.c. was at once injected at about 2 p.m. 31st May—Temperature, 105° at 12·15 p.m.; he is drowsy but not in pain, and pulse fairly good; three or four femoral glands could now be felt, enlarged to about the size of small almond and tender; the lymphangitis no longer seen; Yersin's serum repeated, 60 c.c. at 1 p.m.; removed to Lismore Hospital during the afternoon; at 8 p.m. temperature 106·4°, pulse, 90; Yersin's serum, 60 c.c. at 8·45 p.m. 1st June—Temperature ranged from 105° at noon to 103·6° at midnight. Pulse never more than 100, but soft. Semi-delirious at times. Vomited occasionally. Bubo now characteristic, the formerly discrete enlarged glands having become matted together. Fluid from this bubo showed innumerable *B. pestis* in smear and gave a pure culture of *B. pestis* when sown on Agar. Yersin's serum, 60 c.c. at 3·30 p.m. and at 9·30 p.m. Nuclein hypodermically—10 a.m. ʒ i, 3 p.m. ʒ i, 6 p.m. and 8 p.m. M. 15. 2nd June—Temperature at 6 a.m. had fallen to 102°, but during the morning it rose, and at 2 p.m. reached 104°, at which level it stayed till 10 p.m. Pulse not above 90. Bubo not increasing in size and not so tender as before. Yersin's serum 60 c.c. at 5·30 p.m. Nuclein 6 a.m. M. 30, 2 p.m. M.15, 10 p.m. M.15. 3rd June—Temperature between 103° and 104° from 6 a.m. till 4 p.m., but after that fell steadily. Pulse good. 4th June—Temperature never rose above 100°. The vesicle on left leg became a pustule, and ultimately a small slough formed which has now separated, leaving a round "punched out" sore. There is to-day a revival of the red blush along the path of the former lymphangitis, and in the thigh a cord of lymphatics can be indistinctly felt. 5th June—Temperature normal all day. In the early morning the pulse fell to 54, and temperature to 97·40°. Bubo now gives no pain, is smaller and more defined. 9th June—Evening temperature for past three days has been 100° or over, and at 6 p.m. to night is 102°; probably due to suppuration in bubo. 15th June—Evening rise and morning remission have continued. Temperature this evening 103°. Bubo freely incised. 23rd June—Temperature fell after opening of bubo, and convalescence progressed uninterruptedly. Discharged from hospital to-day.

Residence.—A good class wooden cottage, clean, and in good repair.

Employment.—Patient was employed in the ironmongery department of Robertson's "Red Flag" store, Molesworth-street. The building is a large general store, constructed of wood and iron, containing a heavy stock of goods, including groceries, ironmongery, clothes, and general produce. Fronts Molesworth-street, but has its back entrance in a lane which also serves McDermott's store, mentioned in connection with previous cases. The back entrances of these two stores are not 20 yards apart. This store was cleaned and searched for rats by the shop employees under the continuous supervision of a Sanitary Inspector and a foreman in the service of the Department, on 1st, 2nd, and 3rd June. Lining boards were removed wherever necessary to give access, and manholes cut for future use. All stock on shelves or floors was turned over, and the whole of the premises sprayed with formalin.

Rats.—At the residence no rats; at the place of employment the proprietor stated that a freshly dead rat was found on 6th May, before my arrival at Lismore. In consequence of this, the back part of the store was overhauled by a gang of men under the Sanitary Inspector. 474 bags of general produce were handled and moved, but only one rat was caught, and no more dead rats found. After the occurrence of Case H, it was learned that a dead rat had been found on 30th May in the groceries department of the store. It is said to have been putrid, and to have been at once burnt, but no information of the matter was given me till two days latter. The date on which this rat was found was the date of attack of this Case H, who worked in the ironmongery department a few feet away. The concealment of this discovery raises a suspicion that other dead rats may have been found between 6th May and 30th May, but during the cleansing operations, 1st to 3rd June, no more carcases were found, though several enclosed spaces in the walls contained abundant rat dung. I have mentioned above the relation of this store with the back lane which serves McDermott's store also (*vide* Case A and seq.), and is connected by a defective box drain with Brown's Creek.

PART III.

PLAGUE IN RATS.

No unusual mortality among rats appears to have attracted attention until the occurrence in the beginning of May of the first human case of plague. Then it was learned that a considerable number—19 or 20—of dead rats had been found in McDermott's store on 22nd and 25th April. Subsequently, the general cleansing operations discovered putrid or mummified rat carcases on several premises in the same neighbourhood; but it seems improbable that the epizootic had been severe or long established before the occurrence of human cases. It should be mentioned that when plague first occurred at Ballina in February, Lismore rats to the number of 52 were examined for plague, with negative results.

On 5th May a mouse, found dead at some auction rooms in Woodlark-street, was examined by Dr. Corlis of Ballina, who, in the smears made from the spleen, found bacilli morphologically resembling *B. pestis*.

On 12th May I began examination of all rats and mice obtained either by cleansing gangs or by the rat-catchers. This examination was maintained until 5th July, first by myself, and after my departure from Lismore on 12th June by Veterinary Inspector J. F. McEachran, M.R.C.V.S. During this period 377 rats and 176 mice were examined (in addition to 367 rats and mice from other towns—Casino, Ballina, Coraki, and Ulmarra—sent to Lismore for examination).

On the first day of systematic examination, namely, 12th May, 2 rats and 1 mouse were found to be plague-infected. The last plague-infected rats or mice were examined on 13th June. Examination of all rats and mice was kept up for three weeks longer—till 7th July—but with negative results.

The following table shows the numbers of rats and mice examined and the number found infected week by week:—

	Week ending—								Total.
	May.		June.					July.	
	18th.	25th.	1st.	8th.	15th.	22nd.	29th.	6th.	
Examined—									
Rats	41	52	98	72	27	34	33	20	377
Mice	43	33	28	21	22	14	9	6	176
Infected—									
Rats	3	3	2	...	3	...	...	...	11
Mice	4	2	...	2	...	...	...	...	8

The available evidence thus indicates that the epizoötic existed from at least the middle of April until the middle of June following. During this time 11 rats and 8 mice of those submitted for examination were found to be infected, but there were many others found dead which were too putrid for satisfactory examination.

These rats and mice were obtained on 11 different premises. The map attached to this report shows the location of these premises, and the dates on which plague-infected rats or mice were obtained. The most striking fact about their location is that eight of the eleven premises are on the bank of, or in the immediate neighbourhood of, Brown's Creek, the watercourse mentioned above as forming the northern boundary of the business part of the town, and joining the river just above the main bridge and wharf used by the ocean steamers. The condition of this creek was such as to attract and harbour rats. For years the persons living on its banks had been accustomed to cast out here their rubbish and most of their house garbage, and besides this accumulation of miscellaneous refuse there was on the banks a thick undergrowth of lantana and other bushes. With a breeding-ground of this description in close proximity to the wharf, it was to be expected that the epizootic would manifest itself here if anywhere. Mention has already been made of the box-drain connecting this creek bank with the lane at the back of McDermott's store (*vide* Cases A, B, C, and D), and of the probability that the mortality among McDermott's rats in April was due to introduction of infected rats *via* this box-drain.

The eight premises in the neighbourhood of Brown's Creek were occupied as follows:—Hotels, 2; auction-rooms (produce, &c.) 3; hotel stables, 1; barber's shop (next to other auction rooms), 1; private stables, 1. The other three premises from which plague infected rodents were obtained were—Hotels, 2; private stables, 1; and 1 private residence in Uralba-street. The last-named place was distant more than half a mile from the nearest other place known to be infected, separated from this by unoccupied park land, and it appeared probable that the infection had been transported. The other three places were not so far distant or so separated as to preclude the idea that they might have become invaded by migrating plague-infected rats.

Besides these eleven premises, which furnished rats proved to be plague-infected, mention should be made here of the hotel premises on which the patient Connell (Case E) lived, where the licensee had found dead rats in the first week of May.

Whence the plague-infected rats were introduced into Lismore must necessarily be a matter for conjecture, but the most reasonable supposition is that they were brought up the river. At Ballina plague rats were found in February, April, and May, and at Woodburn in March, April, and May. The frequent communication by steamer between these places and Lismore has already been described and obviously offered abundant facilities for such transport of rats, despite all precautions, such as rat-guards, tarred mooring lines, &c.

Connection of cases with plague infected rats.—With the exception of Connell (Case E), of whose movements no one could give certain information, and who may have been infected at his place of residence, all the cases notified were connected either with McDermott's store or with the lane or premises at the rear. Cases A, C, and D had been employed in the store, Case B had been in the shop on the day when the dead rats were found, Case F had been for some hours hanging about watching the cleansing gang at work, Case G was one of the foremen directing this cleansing work, and Case H was employed in a neighbouring store whose back entrance was in the same lane.

It is worthy of note that none of the eleven premises abovementioned as furnishing plague-infected rats furnished patients also, and this although three were hotels and the other premises of such a character as to be much frequented.

PART IV.

ADMINISTRATIVE MEASURES.

1. *Disposal of Patients.*

No difficulties in regard to this matter arose at Lismore. The patients were taken to the District Hospital and lodged in what used to be the main hospital, but is now empty since the erection of the new building. The hospital staff was supplemented by two nurses from the Coast Hospital who had had previous experience of plague. Medical care of the cases was undertaken by the medical staff of the hospital.

2. *Operations for the Cleansing and Disinfecting of Premises.*

These were initiated by the Council as soon as the first case was verified. Notices under Public Health Act, section 34, were served on all householders, requiring immediate cleansing, in default of which the Council would do the work at the expense of the householder. As a result of these notices, more than 100 loads of rubbish were carted by householders from private premises to the municipal tip. The majority of householders, however, did not themselves carry out the cleansing of premises, and for such the Council engaged a cleansing gang of thirteen men, who worked under the immediate direction and supervision of an experienced Sanitary Inspector and two foremen, despatched from Sydney by the Department for this purpose. This proved to be a satisfactory arrangement. The work comprised removal of all unnecessary lumber from yards and from under houses, search for and destruction of rats and rat-burrows, and thorough treatment with formalin spray, liquid carbolic, or chloride of lime, of all premises where rats were known or suspected to have been found dead. Note was taken of the time occupied in dealing with each place, and as soon as the work was finished the Council served the occupier with a bill for the cost of labour and disinfectants used. In most cases the charges were paid at once; but, in the few instances of refusal, the occupier was promptly served with a summons for a breach of the Municipal By-laws, in that he allowed filth to remain on his premises. In one case, in which the occupier refused to pay the original charge of 12s. 6d., he was fined £3, with 15s. costs.

When the premises throughout the town proper had been thus dealt with, Brown's Creek was taken in hand, and a complete clearance made of the dense undergrowth on its banks, more especially between Molesworth and Keen Streets.

Additional measures for destruction of rats comprised the setting of traps by an employee of the Council, who every morning brought his catch to be examined; and the free distribution at the Council Chambers of poison baits to all who chose to apply; but the total number accounted for was small, only 377 rats and 176 mice in eight weeks, and there was reason to believe that rats were not numerous in the town. In the beginning of June the Council advertised a capitation fee of 3d. per rat; but this did not cause any increase in the daily numbers delivered for examination.

3. *Quarantine and Trade Restrictions.*

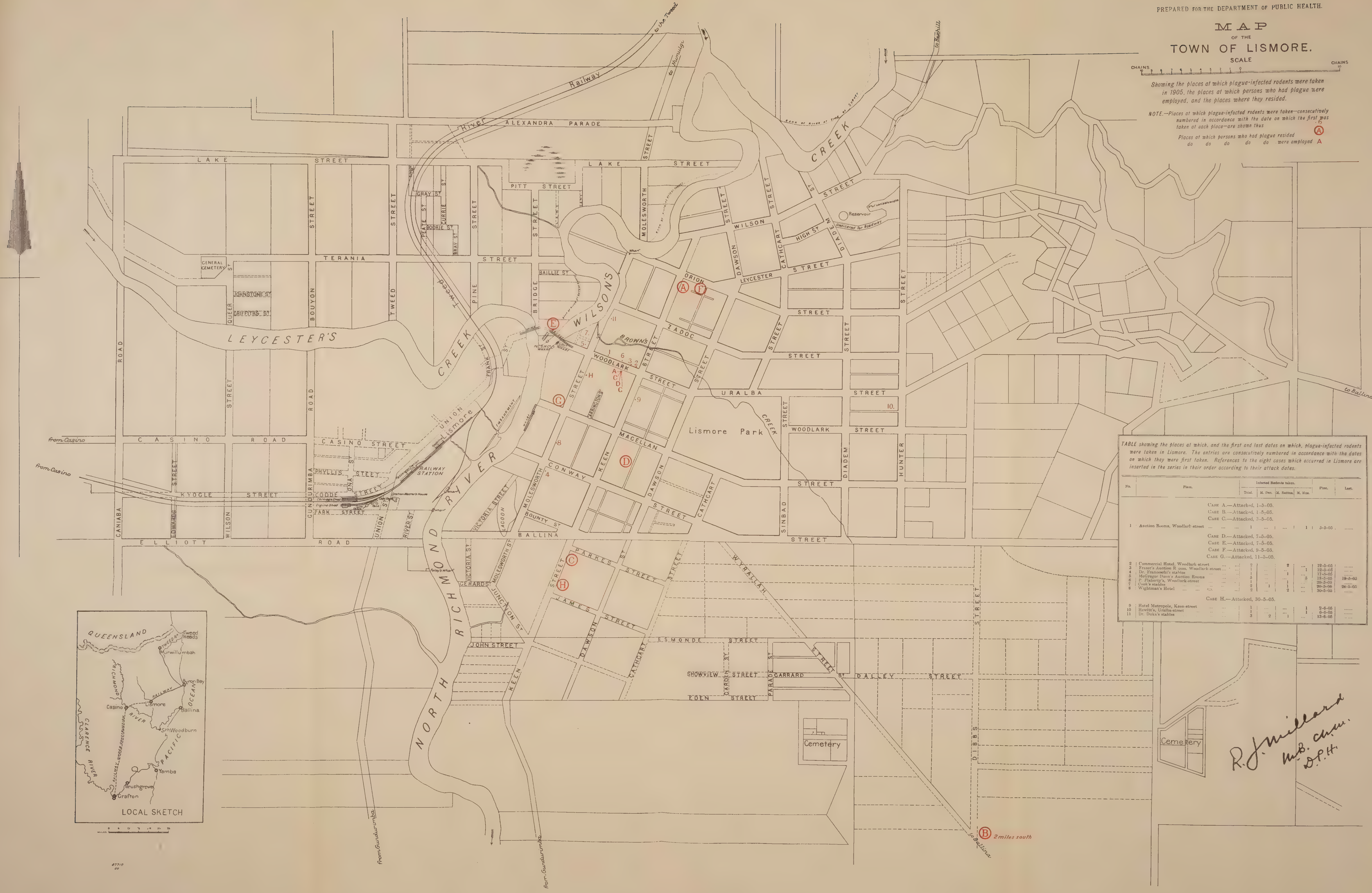
Trade restrictions applied only to grain and fodder as being the goods most likely to favour the transport of rats. The export of these was prohibited unless the shipment went direct to Sydney, where special precautions as to fumigation could be ensured. With the object of preventing transport of infected rats from Lismore, the steamers regularly plying from Sydney to the Richmond River were fumigated with sulphur in Sydney every week, and the same treatment was applied to the Brisbane trader—s.s. "Pyrmont"—on her weekly visit to Lismore. It was not found necessary to "quarantine" any premises. Both the large general stores which furnished plague patients were closed by their proprietors voluntarily during the cleansing operations.

R. J. MILLARD,
Assistant Medical Officer of Government, and Assistant Microbiologist.

REPORT

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF LISMORE.



Showing the places at which plague-infected rodents were taken in 1905, the places at which persons who had plague were employed, and the places where they resided.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ·6

Places at which persons who had plague resided Ⓐ

do do do do do were employed A

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents were taken in Lismore. The entries are consecutively numbered in accordance with the dates on which they were first taken. References to the eight cases which occurred in Lismore are inserted in the series in their order according to their attack dates.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus.	M. Mus.		
	CASE A.—Attacked, 1-5-05.						
	CASE B.—Attacked, 1-5-05.						
	CASE C.—Attacked, 3-5-05.						
1	Auction Rooms, Woodlark-street	1	...	...	1	5-5-05	......
	CASE D.—Attacked, 7-5-05.						
	CASE E.—Attacked, 7-5-05.						
	CASE F.—Attacked, 9-5-05.						
	CASE G.—Attacked, 11-5-05.						
2	Commercial Hotel, Woodlark-street	2	...	2	...	12-5-05	......
3	Frazer's Auction Rooms, Woodlark-street	1	...	..	1	12-5-05	......
4	Dr. Franceschi's stables	1	...	1	...	17-5-05	......
5	McGregor Dunn's Auction Rooms ...	5	...	...	5	18-5-05	19-5-05
6	P. Flaherty's, Woodlark-street	1	..	1	...	20-5-05	......
7	Cook's stables	2	1	1	...	20-5-06	24-5-05
8	Wightman's Hotel	2	...	2	...	30-5-05	......
	CASE H.—Attacked, 30-5-05.						
9	Hotel Metropole, Keen-street	1	...	...	1	2-6-05	......
10	Hewitt's, Uralba-street	1	...	...	1	6-6-05	......
11	Dr. Duka's stables	3	2	1	...	13-6-05	......

R. J. Millard
M.B. Ch.M.
D.P.H.

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

REPORT

ON AN

Outbreak of Plague at Newcastle, New South Wales, 1905.

By ROBERT DICK, M.B., Ch.M. (Syd.), D.P.H. (Camb.),
Medical Officer of Health for the Hunter River Combined Sanitary Districts.

The Medical Officer of Health, Hunter River District, to the President of the Board of Health.

GENERAL CONDITIONS AT NEWCASTLE.

7 November, 1905.

The City of Newcastle is placed on the south side of the river Hunter at its termination in the South Pacific Ocean, in latitude 32·57 S., 70 miles north of Sydney by sea. Population of city—census 1901—14,250, present estimated population, 15,000. Population of district, including immediate suburbs—census 1901—43,269. Present estimated population, 45,800. The tonnage entered during 1904 was 2,086,873.

2. The trade of the city is principally concerned with the shipment of coal produced from the many coal mines in the district. The city also acts as a large distributing centre for the northern parts of the State. It is in daily communication by rail and sea with Sydney, and at short intervals with the northern ports of the State, with Queensland, and with the rest of the Commonwealth, as well as with many other parts of the world.

3. In Newcastle itself, there are many old and ill-kept buildings, though these have been somewhat reduced in numbers, as a result of proceedings under the Public Health Act, during the past five years.

4. The city and district are provided with an abundant supply of good water for drinking and domestic purposes.

5. About three-quarters of the city is sewered, but the sewers and drains, originally constructed for stormwater purposes only, are very defective, and with few exceptions, discharge on to the foreshores of the harbour, under the wharfs, where they are a fruitful source of nuisance. It is clear that these arrangements are attended with grave danger, when considered in relation to plague, and its association with rats. A new sewerage system for the city and district, is now under construction, but after this is provided, the old sewers will, no doubt, be retained for the conveyance of storm waters.

6. A considerable area of the foreshores of the harbour, especially on the city side, has been reclaimed by means of stone ballast, and the shores under the wharfs are faced with this material, which affords ample scope for the harbourage of rats.

EARLIER CASES OBSERVED AT NEWCASTLE.

7. The year 1900 was marked by the first recorded appearance of plague in Australasia. In Sydney, during that year, 303 cases of the disease were notified, of which 103 proved fatal. Cases of the disease have been reported in the metropolis during each succeeding year, down to the present time.

8. In 1902, two cases of the disease were notified at Newcastle. The first was that of F.J., m., æt. 43 years, employed as steward on board the barque "Eulomene." This vessel arrived in Port Hunter, from Sydney, on 7th March, 1902. On 17th March (ten days after her arrival) F.J. was taken ill, and was removed to Newcastle hospital, and later to the Quarantine hospital at North Stockton. On 19th March, the case was diagnosed as bubonic plague. Left axillary bubo, morphological, cultural, and inoculation tests positive. The attack proved a mild one. He was discharged from hopital, cured, on 20th April, 1902. No further cases occurred amongst the other 22 persons forming the ship's company. (See Report, Sydney, 1902, pars. 66–73.)

9. The origin of infection in this case, was attributed to Sydney.

10. The second, and that, apparently, an indigenous case, happened in the person of T.O'N., m., æt. 19, single, no previous attack, not inoculated, employed continuously for about three months prior to attack as porter and cellarman at an hotel, in Hunter-street, Newcastle. Date of attack, 3rd August, 1902, admitted to hospital, 4th August, 1902, died 7th August, 1902; duration of illness, 4 days. Left femoral bubo, morphological, cultural, and inoculation tests positive. The source of infection in this case was not clear. The patient was employed as porter and cellarman at a large hotel in the principal business centre of the city. As part of his work he was in the habit of opening out, handling, and repacking commercial travellers' goods obtained from many different sources in Sydney, in which city 139 cases of plague had been notified between January and 30th June, 1902, and plague-infected rats continued to be found down to 14th July, 1902. He was also employed regularly in the cellar of the hotel several hours a day. The floor of this cellar was found riddled with rat runs, and contained a defective drain leading to a sewer, which ran under the wharf, discharging on to the foreshores at a point about 150 yards distant from the hotel. Steamers which ply daily from Sydney are moored at this wharf. Whilst in Sydney they lay at a wharf about which numbers of plague-infected rats continued to be found. The licensee of the hotel and the patient stated that a number of dead rats had been found and removed from the cellar of the hotel during a week or ten days prior to the onset of the patient's illness. No poison had been laid about the hotel premises. During the cleansing of this cellar by the cleansing staff two dead rats were discovered, but they were in an advanced stage of decomposition, and were useless for the purposes of bacteriological examination. No further cases of the disease occurred amongst the inmates of the hotel, and no other cases were reported in the city or district. (See Report of the Board of Health on "A Second Outbreak of Plague at Sydney, 1902," by Dr. Ashburton Thompson, pars. 183–193.)

11. Following on the notification of this case of plague, a systematic examination of rats procured from different parts of the city was undertaken. A rat staff consisting of twelve men, organised on 8th August, obtained 1,598 rats from 125 different premises in the city, all of which were examined by me, but none of them were found infected.

12. Prior to 8th August, 1902, the destruction of rats had been carried out to some extent in the Newcastle district. During the period 11th May to 30th June, 1901, 32,581 rodents had been destroyed in the incinerator. The work was resumed on 6th March, 1902, and was continued to 11th September, 1902. During this latter period, 14,901 rodents were destroyed in the incinerator; but, with the exception of the 1,598 rats procured by the rat staff between 8th August and 11th September, 1902, no systematic examination of rodents was carried out in Newcastle.

13. Since the notification of the last-mentioned case (T.O'N.), in Newcastle, on 4th August, 1902, no further case of plague was reported down to 25th March, 1905.

THE OUTBREAK, 1905.

14. The circumstances surrounding the fourteen cases of plague, comprising the present epidemic, may be set out as follows:—

Case A.

Summary.—G.P., m., æt. 23, unmarried; no previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, as a suspicious case of plague, at 5 p.m., 25th March, 1905; visited by me, 7 p.m., 25th March. Discharged from hospital, cured, 26th April, 1905; duration of illness, 35 days. Right femoral bubo; morphological, cultural, and inoculation tests positive; guinea pig inoculated subcutaneously in thigh with fluid drawn off from bubo, died of plague in 76 hours.

Resided with parents at 83, Darby-street, and employed as assistant in a produce store at 183, Hunter-street.

Movements prior to Attack.—Continuously employed as assistant in the produce store referred to, for more than a year; occupied in stacking, weighing, and loading pollard, maize, oats, and other forms of produce on the second and third floors of the main store. Usually took his dinner to the store, and ate it there.

History of Illness.—Worked regularly at the produce store up to 22nd March, when at about 3 p.m. on that date, whilst at work, he got headache and felt a sharp pain in his right groin. There was no vomiting or shivering. He stayed about the produce store till 5 p.m., when he walked home, a distance of about half-mile, and lay down in bed, and remained there during 23rd and 24th March. On 23rd March, a painful swelling developed in the right groin, and increased in size during 24th and 25th March. On the latter date he walked up to the Newcastle Hospital, a distance of about a mile from his home, and presented himself for treatment in the out-patient department. He had not been attended by a medical man whilst he lay ill at home. On examination by the resident medical officer at the hospital, the case was looked on as suspicious of plague, and he was admitted. On examination by me at 7 p.m. that evening, he was found to be fairly alert, and gave a coherent account of his movements and of the onset of his illness. Tongue coated down centre with whitish fur. In the right femoral region there was an enlarged and tender gland the size of a walnut, with slight periadenitic thickening about it, and the skin over the gland was somewhat reddened. There were several flea-bites down the front of the right lower extremity, and one conspicuous immediately superficial to the bubo. Temp. 101; P. 96. The attack proved a mild one, the temperature dropping to normal on the third day after admission to hospital. The bubo broke down, and took a long time to heal.

Residence.—A two-storied semi-detached weatherboard building, clean, and in good repair; connected to sewer; defective D trap on drain; pail closet, no trade carried on; no stables. Disinfected 26th March, 1905.

Employment.—A large semi-detached three-storied brick building, portion of the ground and first floors being devoted to offices, and the remainder to the business of a produce store, butter and bacon factories. The building was in good repair; connected to sewer. On the ground floor there was a wooden platform with a space of about 1 foot between it and the earth, and one of the upper floors was ceiled in part. There were large stocks of maize, oats, flour, pollard, and other forms of produce and groceries stored on the second and third floors of the building where the patient worked. The butter and bacon factories were placed in wings connected to the main store, the former opening direct off the first flat.

Rats.—At residence, no signs. At employment, during the overhaul by the cleansing gang of the produce on the second floor where the patient worked, 2 plague-infected rats were found on 29th March. On the ground floor of the building, under the wooden platform referred to above, 2 plague-infected rats had been discovered, together with the putrid carcases of 40 other rats, on 28th March. On another detached part of this produce store, separated from the main store by a narrow street, 2 more plague-infected rodents were discovered on 7th April (it was in this part of the establishment that Case E worked), whilst in two dwellings, forming part of a terrace of houses abutting on the main store, 6 plague-infected rats were found, together with the putrid carcases of 12 other rats, between 31st March and 4th April.

Contacts and further Cases.—At residence, 4; employed in same parts of main store as the patient, 10. No further cases occurred amongst these persons. Case E was also employed at this produce store, but in that detached part of it referred to above where 2 plague-infected rodents, as well as a number of putrid and desiccated carcases of rats, were discovered between 1st and 7th April.

CASE B.

Summary.—W.McK., m., æt. 16, unmarried, no occupation. Resided with his parents at 181, Hunter-street, Newcastle. No previous attack; not inoculated. Notified by Dr. J. L. Beeston at 10 a.m., 27th March; visited by me at 11 a.m., 27th March. Admitted to Newcastle Hospital, 28th March; died, 2nd April; duration of illness, 8 days. Left femoral bubo; morphological, cultural, and inoculation tests positive. A guinea-pig inoculated subcutaneously in thigh with fluid withdrawn from bubo died of plague in seventy-two hours. His parents kept a pastrycook shop next door to the produce store at which Case A worked. The third floors of these two premises were in direct communication with each other through holes in the parti-wall, whilst the yard of W.McK.'s residence abutted on the wall of the produce store and opened on to a common passage leading from the ground floor of the produce store. This passage was boarded over in continuation with the wooden platform referred under Case A.

Movements prior to Attack.—Left Newcastle for Sydney on 19th March, 1905, and stayed at Park-road, Paddington; returned to Newcastle at 8 p.m. on 22nd March, 1905. During his stay in Sydney did not visit any wharves there, nor was there any history of plague in rats or man at his place of abode whilst in the metropolis. Did not visit the produce store next door to his residence in Newcastle, nor did he know Case A.

History of Illness.—Began with sudden onset on 25th March, 1905; experienced headache, but no vomiting or shivering. A painful condition of the left groin followed, and a tender swelling was felt in this region on the evening of 25th March, 1905. During 26th March, 1905, headache continued, and the swelling in the left groin increased in size, and was associated with some periadenitic effusion. No lesions noticeable on the left lower extremity. The furthur course of his illness was marked by great increase in size of the bubo, with very extensive inflammatory œdema spreading up on to the abdomen and down on the thigh. Two days prior to death, painful swellings formed in the scalp tissue; one of these, on being incised, was found to consist of gelatinous material, swarming with *B. pestis*; delirium marked during last three days of illness. Received 380 c.c. Yersin's serum during the course of his illness.

Residence.—A two-storied brick building, wedged in between a produce store and seedsman's shop, the ground floor being devoted to a pastrycook's shop and refreshment room. Premises in good repair and generally clean; connected to sewer. Disinfected, 29th March, 1905.

Employment.—Nil; he had recently left school, and was waiting engagement in connection with office work.

Rats.—At residence, his parents stated that in the bedroom usually occupied by the patient there had been, for the week previous to his attack, a very foul odour, which they ascribed to dead rats. On search being made by the cleansing gang, on 29th March, 1905, one dead mouse was found under the flooring of this room, and three dead rats over the ceiling of it. All four were in an advanced state of decomposition. There was direct connection between these premises and the produce store next door, on which several plague-infected rats, and many putrid dead carcases of rats, were found, as detailed under Case A.

Contacts and further Cases.—At residence, 8. No further cases occurred.

CASE C.

Summary.—R.K., m., æt. 18, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by Dr. A. J. C. Crawley, 9 p.m., 28th March, 1905; visited by me, at 10 p.m., 28th March, 1905; admitted to Newcastle Hospital, 29th March, 1905; discharged cured, 27th May, 1905; duration of illness, 60 days. Resided with his parents at 202, Darby-street, Newcastle, and worked as attendant on a biscuit-moulding machine, at a large biscuit factory employing about 700 hands, situated in Melville-street, about a half mile distant from his residence. Left femoral bubo; morphological, cultural, and inoculation tests positive. A guinea-pig inoculated subcutaneously with fluid drawn off from the bubo died of plague in 74 hours.

Movements prior to Attack.—Woke on the morning of 28th March, 1905, feeling quite well, and went to his work as usual at 7 a.m. At 8 a.m. he felt sick, and reported himself to the foreman of the particular branch of the work at which he was employed in the biscuit factory, who told him to go home. Arrived home at 9 a.m. in a delirious condition, and could not give his parents any account of himself. When seen by me at 10 p.m., 28th March, 1905, at his home, he had noisy delirium, and lay curled up in bed, resisting any movements of his limbs. Pressure in the left femoral region excited much distress, and here there was to be felt a somewhat enlarged gland; T. 103, P. 100; body very dirty, with numerous flea-bites present on the limbs. Bubo broke down, and took a very long time to heal. Received 120 c.c. Yersin's serum during the course of his illness.

Residence.—A detached weatherboard cottage in poor repair, abutting on a large stable and produce store, and adjoining a marine dealer's premises; pail closet, but premises connected with sewer, the house-drain being structurally defective. Fowl-house and shed in yard, together with stacks of secondhand timber. Premises disinfected 29th March, 1905.

Employment.—A large, well-appointed, and structurally sound building, at which about 700 hands, male and female, were employed; connected with sewer; stables in yard at rear.

Rats.—At residence, 4 rats, 1 plague-infected, were caught on 1st April, 1905. At the marine store adjoining, 2 plague-infected rats were taken on 4th April, 1905, and at premises next to this, 1 plague infected rat was found on 1st April, 1905.

At Employment.—No traces of rat-infestation in that part of the factory where the patient was regularly employed. Some evidences of them, however, in the flour store, and about the latrines, as well as in that part of the building devoted to offices. Though many attempts were made to obtain rats for examination from these premises, none were procurable. There was no history of dead rats having been seen in any part of the establishment.

Contacts and further Cases.—At residence, 3; at employment (in that part of the building where the patient regularly worked), 43. No further cases occurred at the residence. Case N present series (date of attack, 2nd July, 1905), was employed at the same factory, but in a different part of the building.

CASE D.

Summary. G.M., m., æt. 23, unmarried. No previous attack; not inoculated; no communication with any previous case; employed as yardman in a marine store at 91, Dawson-street, Newcastle. Resided with parent at 14, Queen-street, Newcastle. Notified by Dr. W. Nickson, 10 a.m. 2nd April, 1905; visited by me, 12 noon, 2nd April, 1905; admitted to Newcastle Hospital, 1st April, 1905; discharged cured, 12th May, 1905; duration of illness, 42 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Worked regularly at the marine store referred to, handling bags, rope, and other articles usually associated with such trade; so employed during several months past.

History of Illnesses—On 31st March, 1905, was carting some rubbish away from the marine store premises, when he was suddenly attacked by vomiting and frontal headache; had to leave off work, and went home to bed; lapsed into a stupid condition, and it was thought by his people that he had had a fit. On 1st April, 1905, felt pain in left groin, and a swelling was noticed there, which rapidly increased in size and was attended by considerable pain. On admission to hospital, bubo was as large as a walnut, very tender; temperature, 103; body in a very dirty and ill-kept condition; numerous flea-bites on both lower extremities, and a number of discharging sores on feet and hands; received 140 c.c. Yersin's serum; gland broke down and took a long time to heal.

Residence.—A semi-detached weatherboard structure in poor repair, fairly clean; connected to sewer; pail closet; no stables or sheds in the immediate vicinity. Premises disinfected 2nd April, 1905.

Employment.—At a marine dealer's premises, which were in a generally dirty and ill-kept state. They adjoined a large produce store and stables.

Rats.—At residence, no traces. At employment, many evidences; 2 plague-infected rats were taken there on 5th April, 1905, during cleansing operations, and 1 plague-infected rat on the premises next door on 1st April, 1905.

Contacts and further Cases—At residence, 8; at employment, 4. No further cases occurred amongst any of these persons.

CASE E.

Summary.—D.D., m., æt. 44, married. No previous attack; not inoculated. Resided in the suburb of Lambton, distant about 4 miles from his place of employment, which was at the produce store in Hunter-street, Newcastle, where Case A worked, though in a different part of those premises. D.D. acted as storeman in charge of that portion of the premises devoted to hay, chaff, and potatoes, across a narrow street and opposite the main store. Died at his residence 27th April, 1905. Duration of illness, 5 days. Septicæmic case; *B. pestis* recovered from spleen and liver at post mortem.

Movements prior to Attack.—Employed for many years past as storeman, handling hay, chaff, and other produce at the produce store referred to. Journeyed daily between his residence at Lambton and his place of employment, and confined himself to that part of the store where he was in charge. Usually took his dinner to the store and ate it there.

CASE F.

J.R.L. Age, 26. Occupation, med. practitioner.
Admitted, 30-4-05. Discharged, 28-5-05. Result, cured.

TEMPERATURE CHART.

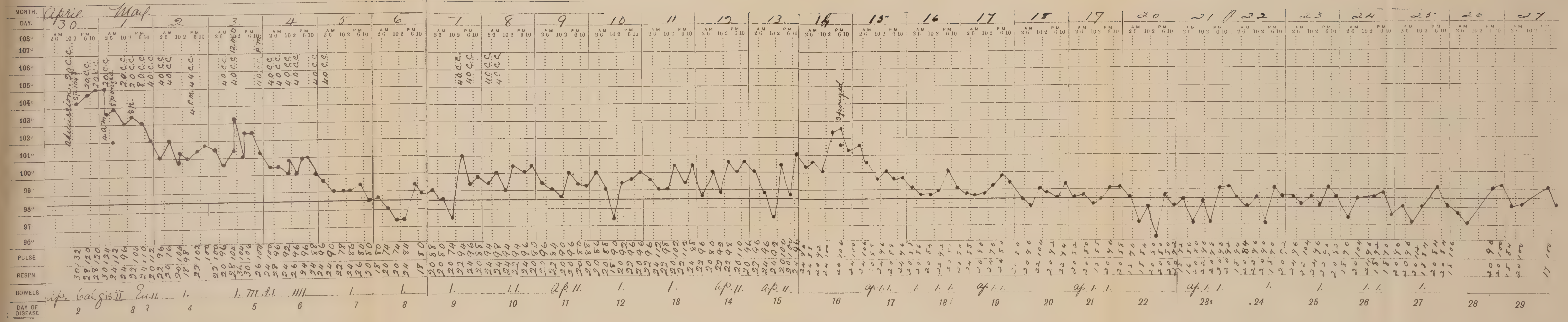


Photo-lithographed by
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Sydney, N.S.W.

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History of Illness.—Worked regularly at the produce store up to 21st April, 1905. Left home for work at 6 a.m. on 22nd April, 1905, but soon after starting was suddenly taken with vomiting. He returned home by tram at 8 a.m. and took to bed. Was seen by a medical man (J.R.L., Case F) on 24th April, 1905. At that time T. 104, P. 120; vomiting a prominent symptom. Died at 5 a.m. 27th April, 1905. The cause of death not being clear the matter was referred to the Coroner, who ordered a *post-mortem*, which was done at 3 p.m. 27th April, 1905, in the Morgue, Newcastle. The *post-mortem* disclosed no obvious lesions on the surface of the body and no apparent enlargement of the superficial groups of glands. The viscera were much congested; blood-stained fluid in pleural and peritoneal sacs; spleen much enlarged, very soft, and with small greyish spots showing on its surface. Smear preparations from the spleen and liver showed swarms of typical *B. pestis.*

Residence.—A detached stone cottage, in good repair and clean; no drains; pail closet; no trade carried on; no stables present. Disinfected, 28th April, 1905.

Employment.—That part of the produce store in Hunter-street, Newcastle, at which he was employed consisted of a series of sheds in very poor repair, with wooden and earthen floors. About 500 tons of produce of various kinds were stored there.

Rats.—At residence, no signs. At employment, in one of the sheds where the patient spent most of his time, 2 plague-infected rats, as well as a number of putrid and desiccated carcases of rats, were discovered on 7th April, 1905, during cleansing operations. No further plague-infected rats were caught or found on these premises after that date, though they were searched. But it is to be noted that this produce store faces the wharves and is distant from them by about 100 yards in a direct line, and that the main sewer (4 feet by 4 feet, square in section) serving the block in which these premises are placed, and the premises themselves discharges, open-mouthed on the foreshores of the harbour. Plague-infected rats continued to be caught about the mouth of this sewer down to 13th May, 1905.

Contacts and further Cases.—At residence, 10; at employment (in that part of the produce store where the patient was occupied), 6. No cases occurred amongst any of these persons.

Case F.

Summary.—J.R.L., m., æt. 26, unmarried, medical practitioner. No former attack; not inoculated. Notified by Dr. F. H. Cox, 9 a.m., 30th April, 1905; visited by me, 10 a.m., 30th April, 1905; admitted to Newcastle Hospital, 30th April, 1905; discharged cured, 28th May, 1905; duration of illness, 31 days. Was engaged in private practice at Lambton, a suburb 4 miles out of Newcastle.

Movements prior to Attack.—He attended the patient D.D. (Case E, present series) from 24th to 27th April, and made the *post mortem* on that case. Left axillary bubo; morphological and cultural tests positive.

History of Illness.—On 27th April, about 4 p.m., during the performance of a *post mortem* on Case E at the Morgue, Newcastle, he made a slight scratch on the skin at the base of the left forefinger, and at the same time two small pieces of skin were knocked off at the base of the right thumb. The latter wounds bled freely and were mopped with pure carbolic acid; the slight scratch on the left hand was not noticed at the time. At 4 p.m., 28th April, 1905, he felt some *malaise*, and experienced frontal headache. During this day, and on 29th April, 1905, he went about his ordinary medical duties, driving out and seeing a number of patients. On the evening of 29th April, 1905, he experienced some pain high up in the left axilla, and felt a slightly enlarged gland there. This increased in size during the night of the 29th, and was accompanied by considerable pain. He passed a restless night. When visited at 10 a.m. on 30th April, 1905, at his residence, he complained of headache and pain in the left axilla. He was dull, with suffused eyes, tongue clean and moist, skin moist; T. 102, P. 120. In the left axilla there was an enlarged and very tender gland, soft to the touch, about the size of a large walnut, with very little periglandular thickening about it. At the base of the left forefinger there was present a small wound with slightly everted edges, which was now recognised as having been made at the *post mortem.* There was no lymphangitis about the wound or up the left arm. Puncture of the bubo yielded *B. pestis* in pure culture. The further course of his illness was very severe. The temperature rose to 105, and continued between 101 and 104 for five days, when it dropped to 99. This intermission was succeeded by a further rise to 100–101, maintained for nine days, when it gradually subsided to normal. The gland increased very considerably in size, and it, with inflammatory œdema, filled the upper part of the axilla. The swelling slowly subsided, and resolved without breaking down. The subcutaneous injection of Yersin's serum was begun on 30th April, 1905, at 10 a.m., and was repeated at four-hour intervals. Altogether 944 c.c. of the serum were given. Very acute muscular and joint pains and a sharp attack of urticaria followed. The temperature chart and other clinical details of this case will be found in the Appendix attached to this Report. It is worthy of note that there was no invasion through the two wounds on the right hand which bled freely, and which were swabbed with pure carbolic acid soon after their infliction.

Residence.—A detached weatherboard cottage in good sanitary state. Bedroom disinfected 1st May, 1905.

Rats.—At residence, no signs.

Contacts and further Cases.—At residence, 4. No further cases occurred.

Case G.

Summary.—E.C.J., m., æt. 17, unmarried, stable boy and carter. No previous attack; not inoculated. No communication with any previous case. Notified by Dr. N. J. Dunlop, 10 p.m., 3rd, May, 1905; visited by me, 9 a.m., 4th May, 1905. Admitted to Newcastle Hospital, 4th May, 1905; died, 6th May, 1905; duration of illness, 3 days. Resided with parents off Corlette-street, Newcastle, and worked in a pastrycook's, at 191, Hunter-street, West Newcastle. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was engaged as carter delivering pastrycook's goods about the city and district, and looked after the horse and cart used in connection with his work. Had been thus employed for several months. The stable at which his horse was fed and stalled lay at some little distance from the pastrycook's shop, on premises used as a furniture and upholsterer's store. The yard of these premises, 199-201, Hunter-street West, adjoined that of a butcher's shop next door, 203-205, Hunter-street West, on which there were a number of stables. These two yards were only partially separated from each other by a dilapidated wooden fence, the entrance to the stable on the upholsterer's premises being through the yard attached to the butcher's shop. Case G frequented the stable at which his own horse was tended, as well as the yard attached to the butcher's shop.

History of Illness.—Went to his work at 7·30 a.m. on 3rd May, 1905. At 8·30 a.m., whilst on his cart delivering goods, he felt ill, shivery, and inclined to vomit. He remained at his work, however, till 3 p.m., when he walked from his place of employment at the pastrycook's shop to his home, a distance of about half a mile. Arrived home in a more or less stupid condition. Complained of headache and pain in right groin. Was very delirious on night of 3rd May, 1905. On examination, 9 a.m., 4th May, 1905, he was found in a stupid condition, tongue moist, coated down centre with thick fur. In right inguinal region an enlarged gland about the size of a shelled almond, with very little periadenitic thickening about it; much distress evinced when the gland was palpated. No lesion apparent on drainage area of bubo. T. 105, P. 120. The further course of his illness was marked by considerable increase in size of the bubo, with inflammatory thickening about it; delirium very marked, and restlessness extreme. Death from heart failure on 6th May, 1905, three days after the onset of his illness. Received 380 c.c. Yersin's serum, spread over thirty hours.

Residence.—A detached weatherboard cottage in good repair and very clean; connected with sewer; some stables on the adjoining premises. Premises disinfected, 4th May, 1905.

Employment.—Pastrycook's shop a semi-detached brick building in fair repair, and generally clean; baking-room with bricked floor; no outhouses; connected with sewer. The stable was in very poor repair; earthen floor; no drainage.

Rats.—At residence, no traces; at employment at the pastrycook's shop, one or two rat-holes were present, but no recent traces of rats. At the stable, rats were numerous. One plague-infected rat was caught there on 20th April, 1905, and 4 were taken in the yard attached to the butcher's shop, 1 on 25th April, 1905, and 3 on 1st May, 1905. The butcher's shop premises were overrun with rats, no less than 67 being killed during cleansing operations, whilst in addition a number of putrid carcases of rats were found there.

Contacts and further Cases.—At residence, 4; at employment at pastrycook's shop, 6. No further cases occurred amongst these persons.

Case H.

Summary.—W.McM., m., æt. 43, married, butcher. No previous attack; not inoculated. Notified by Dr. A. J. C. Crawley, 11 a.m., 6th May, 1905. Admitted to Newcastle Hospital, 6th May, 1905; discharged cured, 6th June, 1905; duration of illness, 43 days. Resided at No. 6, Auckland-street, Newcastle, and worked as butcher in the butcher's shop at 203-205, Hunter-street West, Newcastle, next door to the furniture and upholsterer's premises referred to under Case G. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed in butcher's shop, where he had worked regularly for several years past. Engaged in the retail portion of the shop and the small goods factory which opened off the rear of the shop; occasionally went about the yard and stables attached to the premises. Knew Case G, but was not in the habit of associating with him.

History of Illness.—Went to his work on 5th May, 1905, in the morning in his usual health. About 10 a.m. he experienced pain in the left groin, with headache and shivering. He walked home, a distance of about a sixth of a mile, and went to bed at 1 p.m. On examination on 6th May, 1905, at noon, T. 103, P. 120, tongue clean, but tending to dryness. A bubo the size of a large marble and surrounded with inflammatory œdema formed a definite prominence in left Scarpa's triangle. No lesions apparent on drainage area of bubo. The bubo finally broke down. Received 680 c.c. Yersin's serum during course of illness.

Residence.—A two-storied brick building, forming one of a terrace, in good repair and generally clean; connected to sewer; pail closet; large stable premises six doors away and on the same side of the street.

Employment.—A brick building used as a butcher's shop, with wooden floors throughout, except in that part of the premises used as a small-goods factory, where there was a poorly-laid brick floor. Stables in the yard at rear in bad repair, earthen floors, very offensive, a large accumulation of manure and refuse about the premises; connected with sewer, but a large square-shaped bricked junction pit just off the small goods factory was found untrapped and without proper cover.

Rats.—At residence, no traces. At employment, premises badly infested. One plague-infected rat identified on 25th April, 1905, 3 on 1st May, 1905, whilst many putrid carcases of rats were discovered during cleansing operations on lifting the wooden floors in different parts of the shop and about other parts of the premises, and 67 rats were killed during these operations. The defective junction pit connected with the drains allowed free ingress and egress to rats. The sewer into which the drains led discharged on the foreshores of the harbour about 100 yards distant, and at a point opposite to the butcher's shop. Plague was identified in 6 rats caught near the spot where this sewer discharges on the foreshores between the dates 18th April, 1905, and 25th April, 1905.

Contacts and further Cases.—At residence, 7; no cases developed amongst any of these persons. At employment, 9; 1 further case, that of D.S., case I, occurred amongst the workmen at the butcher's shop.

Case I.

Summary.—D.S., m., æt. 17, unmarried. No previous attack; not inoculated. Notified by Dr. A. J. C. Crawley, 6·30 p.m., 13th May, 1905; visited by me, 8·30 p.m., 13th May, 1905; admitted to Newcastle Hospital, 14th May, 1905; discharged cured, 31st May, 1905; duration of illness, 21 days. Resided with his parents at William-street, North Waratah, distant 4 miles from his place of employment at the butcher's shop, 203-205, Hunter-street West, Newcastle, where W. McM., Case H., was employed Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed as stable boy and carter at the butcher's shop, looking after the horses, and was also employed carting meat from the slaughter-house at North Waratah to the butcher's shop. Had been thus employed for several months.

History of Illness.—At 5 p.m., 11th May, 1905, just after finishing carting scrap meat from the butcher's shop to the slaughter-house at North Waratah he had a shivering attack and slight vomiting. He walked home, a distance of about half a mile, and lay down in bed. A painful swelling in the left groin was noticed on the morning of the 12th May, 1905. This gradually increased in size. No medical man was called in to attend the patient until 13th May, 1905, when Dr. Crawley saw him and notified the case to me. On examination at 8 p.m., 13th May, 1905, he was found in bed with suffused eyes and intolerant of light, tongue thickly coated down centre with fur; T. 102, P. 100. In left femoral region there was an enlarged and very tender gland the size of an unshelled almond; no lesions apparent on drainage area of bubo. The case pursued a mild course, and the bubo subsided without going on to suppuration. Received 160 c.c. Yersin's serum in 16 hours.

Residence.—A detached weatherboard cottage in fair repair and generally clean; no drains; pail closet; a detached milk-room and stable at rear. The father of the patient carried on the business of a registered milk vendor. He received milk from a farm in another part of the district, and distributed it in Newcastle and suburbs. The milk was met at the jetty on the river near by, the vendor then started on his rounds and rarely returned any milk for storage at his registered premises in Waratah.

Employment.—As set out under Case H.

Rats.—At residence, no traces. At employment, as set out under Case H.

Contacts and further Cases.—At residence, 4; at employment, 9. No further cases occurred amongst any of these persons.

CASE J.

Summary.—D. McL., m., æt. 35, married. No previous attack; not inoculated; no communication with any previous case. Notified from Newcastle Hospital by the Resident Medical Officer on 21st May, 1905, at 1 p.m.; visited by me, 4 p.m., 21st May, 1905. Admitted to Newcastle Hospital, 21st May, 1905; discharged cured, 16th June, 1905; duration of illness, 29 days. Resided at Nobbys-road, Newcastle, and employed as storeman at a large general merchant's premises in Bond-street, Newcastle. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed as storeman on first and second floors of a large general merchant's premises in Bond-street, where groceries were principally handled. Had been so employed for several years past. Last at work, 19th May, 1905, at 5 p.m.

History of Illness.—At 7 p.m. 19th May, 1905, after having had his tea, he experienced sharp pain in right groin and had a shivering attack. Took to bed, and suffered from severe headache. On 20th May, 1905, felt painful swelling in right groin. Seen by medical man 21st May, 1905, and admitted to hospital same day. When examined after admission to hospital he was found with suffused eyes, tongue dry and coated down centre with thick white fur; temperature, 101. In right inguinal region painful gland, size of unshelled almond, slight amount of inflammatory œdema about it, and redness of skin superficial to it. No lesions apparent on drainage area of bubo. Gland increased in size and broke down.

Residence.—A detached weatherboard cottage in good repair and clean; no drains; pail closet; no stables. Disinfected 21st May, 1905.

Employment.—A large detached three-storied brick building, in sound repair, used by general merchants. One end of the building is a bonded store. Portion of the ground floor used as offices in connection with the business. The merchandise dealt with consisted of hardware, timber, groceries, and in a detached galvanized iron shed at the rear, articles of produce, such as chaff, hay, maize, &c., were stored. The basement floors were of concrete, but with wooden platforms 6 inches high over them; the rest of the floors were of wood. The first floor was the only one with a ceiling to it. There were double partitions separating different sets of offices on the ground floor. Connected with sewer.

Rats.—At residence, no traces; at employment, many evidences. On the two floors of the main store where the patient worked, 7 plague-infected rodents were taken between 3rd May, 1905, and 25th May, 1905. In the ceiled part of the first floor, which was searched, the carcases of 4 putrid rats were found. Two of these were lodged immediately under that spot where the patient sat at his desk, and where a part of the flooring was defective, a board having been left up next the wall against which the desk was placed. Two plague rats were also identified amongst those found in the shed at the rear where produce was stored on 8th May, 1905.

Facing the main building, on the opposite side of Bond-street, which is a narrow thoroughfare, are a row of sheds in which a large amount of produce was stored. In these sheds 11 plague-infected rats were found during the period 24th May, 1905, and 1st June, 1905. And in another produce store in Telford-street, at its junction with Bond-street, and opposite the western end of the main store, 6 plague-infected rats were taken between 15th May, 1905, and 30th May, 1905.

Contacts and further Cases.—At residence, 5; at employment (in that part of the building where the patient usually worked), 4. No further cases occurred amongst any of these persons.

CASE K.

Summary.—S.E.T., m., æt. 19, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by Dr. J. L. Beeston, 10 p.m., 27th May, 1905; visited by me, 10 a.m., 28th May, 1905. Admitted to Newcastle Hospital, 27th May, 1905; discharged cured, 28th June, 1905; duration of illness, 34 days. Resided at the Railway Refreshment-room premises, Newcastle, where he was employed as porter and useful hand. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Employed for several years past as porter and useful hand about the kitchen and yard premises at the Railway Refreshment Rooms, Scott-street, Newcastle. Last at work, 9 p.m., 26th May, 1905.

History of Illness.—At 9 p.m. 26th May, 1905, three hours after his tea, he had an attack of vomiting, followed by headache. Rose at 6·30 a.m., 27th May, 1905, and started his ordinary work, but was obliged to give up at 8 a.m. on account of faintness and painful condition of the right groin. Seen by medical man at 12 noon. On admission to hospital was found with dry tongue; T., 103; P., 108; in right inguinal region an enlarged and tender gland the size of a filbert, with small amount of thickening surrounding it; no lesion apparent on the drainage area of the bubo. Had a fairly mild attack. Bubo suppurated.

Residence.—A large two-storied brick building, being part of the main railway station for the city. Patient slept in a small room off the kitchen attached to the refreshment-room portion of the building. No stables. A number of fowls kept on the premises. Connected to sewer. Bedroom disinfected 27th May, 1905.

Employment.—As above. Wooden floors throughout the building. The yard was covered with a thin layer of asphalt in defective state of repair.

Rats.—At residence and employment. One plague-infected rat taken on 6th May, 1905. The premises are distant about 50 yards from the wharves, and separated from them by the railway tracks. A large 4 feet by 4 feet sewer, square in section, with the sides and bottom formed of loosely set rubble, runs along the centre of the footway by the side of the building, and into it the drains from the patient's residence and place of employment fall. This sewer discharges open-mouthed under the wharf almost immediately opposite, and distant about 50 yards from the railway station. Six plague-infected rats were taken at this wharf at intervals between 6th April, 1905, and 30th June, 1905. The yard of the premises at which the patient was employed, and neighbouring offices placed near the sewer referred to above, were reported to have been infested with rats, and on examination the yard and ground bordering this sewer were found to be honeycombed by rat runs.

Contacts and further Cases.—At residence and employment, 8. No further cases occurred.

Case L.

Summary.—G.St.C.W., m., æt. 48, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, at 10 a.m. 30th May, 1905; visited by me, 11 a.m., 30th May, 1905. Admitted to Newcastle Hospital, 29th May, 1905; discharged cured, 18th July, 1905; duration of illness, 51 days. Resided at 96, King-street, Newcastle, and employed as jobbing carpenter about the city. Left axillary bubo; morphological and cultural tests positive.

Movements prior to Attack.—Employed during the past ten days as carpenter at 299, Hunter-street West, Newcastle; frequented the wharves and other parts of the town when off work; last at work, 29th May, 1905.

History of Illness.—At 4 p.m., 29th May, 1905, whilst engaged doing some carpentering work on the premises mentioned above, was attacked by severe rigor and felt pain in the left armpit. Had to leave off work, and betook himself to his lodgings at 96, King-street, where he lay down for a few hours and was then conveyed to the Newcastle Hospital. When seen in hospital he was in a more or less stupid condition, with dusky complexion, tongue dry, with brownish fur. In left axilla a large, soft, and tender gland the size of a large walnut. T., 103·5; P., 120. No lesions apparent on the drainage area of the bubo. He passed through a severe attack of the disease; violent delirium for several days. Bubo broke down and took a long time to heal up. Received 580 c.c. Yersin's serum during the course of his illness.

Residence.—He lodged with a family occupying one of a row of three small weatherboard cottages, in fair repair, and generally clean; connected to sewer; pail closet; large stables on the adjoining premises, at the rear of the cottage. Disinfected, 31st May, 1905.

Employment.—During ten days prior to attack employed at small athletic ground fronting Hunter-street West, Newcastle; shops and dwellings on two sides of it, open land at the rear.

Rats.—At residence, several rat-holes in floors of skillion part of the premises. On the stable premises, at the rear of the dwelling, 1 plague-infected rat was taken on 5th May, 1905, and on premises adjoining these, 17 plague-infected rats were found on dates between 2nd May, 1905, and 22nd May, 1905. At employment, no traces.

Contacts and further Cases.—At residence, 3; at employment, 4. No further cases occurred.

Case M.

Summary.—H.J., m., æt. 17, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, 9 a.m., 4th June, 1905; visited by me, 10 a.m., 4th June, 1905; admitted to Newcastle Hospital, 3rd June, 1905; discharged cured, 27th June, 1905; duration of illness, 29 days. Right inguinal bubo; morphological and cultural tests positive. Resided with his parents at Macquarie-street, Merewether, a suburb of Newcastle, and worked as stable boy at a large colliery off Darby-street, Newcastle.

Movements prior to Attack.—Employed each day regularly as stable boy at the colliery for several months past. Walked from his home to his work every morning, a distance of about 1½ miles, and returned direct home every night after finishing his work. Last at work, 29th May, 1905.

History of Illness.—On getting up at 4 a.m., 30th May, 1905, to proceed to his work, he felt giddy, and fell down; took to bed, where he remained. Headache set in, and pain in right groin. Seen by a medical man on 31st May, 1905, on which date T. 101. There was then present a slightly enlarged and tender gland in the right inguinal region. The case was not notified, however, until 3rd June, 1905, at 7·30 p.m. On admission to hospital, 3rd June, 1905, T., 104; P., 120; right inguinal bubo size of unshelled almond, firm, and tender to touch; slight periadenitic thickening. No lesions noticeable on drainage area of bubo. Case ran a mild course; gland did not break down.

Residence.—A weatherboard cottage, situated on elevated ground in Macquarie-street, Merewether, about 1½ miles from Newcastle, in good repair and clean ; no drains ; pail closet ; no stables on or near the premises. Bedroom disinfected, 5th June, 1905.

Employment.—As stable boy at a colliery, off Darby-street, Newcastle, where there were forty horses employed in and about the mine. These horses were stalled and fed in two long rows of stables near the pit top. There was a detached feed-room near the stables. The patient and another employee fed and groomed these horses daily. Stalls with stone floors ; feed-room wooden floor, elevated about 6 inches off the ground ; premises generally clean.

Rats.—At residence, no signs. At employment, the putrid carcases of 2 rats were found in the feed-room at the colliery where the patient worked. The feed (chaff, hay, maize, &c.) stored in this room was brought every day or two from a produce store on the wharf belonging to the same company which owned the colliery. Nine plague-infected rats were taken at this wharf between 17th April, 1905, and 13th May, 1905. On overhauling the produce store on this wharf on 7th June, 1905, several putrid and desiccated carcases of rats were discovered.

Contacts and further Cases.—At residence, 11 ; at employment, 1. No further cases occurred amongst these persons.

Case N.

Summary.—J.J.McD., m., æt. 15, unmarried. No previous attack ; not inoculated. Notified by Dr. E. J. S. Spark at 3 p.m., 3rd July, 1905 ; visited by me, 5 p.m., 3rd July, 1905. Admitted to Newcastle Hospital, 3rd July, 1905 ; discharged cured, 1st August, 1905 ; duration of illness, 31 days. Resided with parents at Stockton, a suburb of Newcastle, situated on the north side of the harbour, and employed at a large biscuit factory in Melville-street, Newcastle, carrying trays and baskets in connection with a biscuit-baking oven, and also at a mixing machine in a small room in the office part of the works. Left inguinal bubo ; morphological and cultural tests positive.

Movements prior to Attack.—Worked regularly during several months past at the biscuit factory, at which there were employed about 700 hands, male and female. Travelled by ferry from Stockton each morning, and returned home each evening after leaving work. He took his lunch to the factory, and ate it on some vacant land just outside the works. Last at work, to 1 p.m. 1st July, 1905.

History of Illness.—At 11 a.m. 2nd July, 1905, had an attack of vomiting and shivering ; about an hour later felt sharp pain in left groin ; took to bed, where he remained till removed to the Newcastle Hospital by ambulance on 3rd July, 1905. On admission, was in a delirious condition ; temperature, 104 ; pulse, 96 ; bubo left inguinal region, size of large walnut, tense and tender ; body very dirty, numerous flea-bites on body and limbs. Attack severe, delirium for several days ; bubo broke down. Received 380 c.c. Yersin's serum during course of illness.

Residence.—A detached weather board cottage in poor repair and unclean condition ; no stables, but fowl-houses and a quantity of lumber in the yard ; no drains ; pail closet. Disinfected 4th July, 1905.

Employment.—A large and substantially-built brick structure in good repair, connected to sewer ; stables at rear of main buildings.

Rats.—At residence, 8 rodents trapped on the premises were all found to be healthy. No evidence of plague infection had at any time been discovered amongst the large number of rats and mice taken in the municipality of Stockton, where the patient's residence was situated. At employment, as in Case C as regards the main buildings. In the small mixing-room, situated in the office part of the premises, where the patient was employed for about one hour a day, there were many rats' holes in the skirtings, floors, and plaster walls, but no plague-infected rats were found on the premises, and no carcases were discovered. It was stated by the patient that he had seen several rats in this small room a week or two before he fell ill. Attempts were made to secure rats on these premises, but without success. At the ferry-landing on the Newcastle side, which the patient frequented, 12 plague-infected rats were taken between 2nd April, 1905, and 6th July, 1905.

Contacts and further Cases.—At residence, 11 ; at employment (in that part of the building where the patient spent most of his time), 40 ; in the small mixing-room, 1. No further cases occurred amongst any of these persons.

Progress of the Epidemic.

15. The following table shows the number of notifications and number of deaths each week :—

Week ending—	Notifications.	Deaths.	Week ending—	Notifications.	Deaths.
April 1	3	1	May 27	3	...
„ 8	1	...	June 3	...	...
„ 15	...	...	„ 10	1	...
„ 22	...	...	„ 17	...	...
„ 29	1	1	„ 24	...	...
May 6	3	1	July 1	...	...
„ 13	1	...	„ 8	1	...
„ 20	..	...			
				14	3

CASES REPORTED FOR DIAGNOSIS.

16. Between 25th March and 12th July, 13 cases were reported to me for diagnosis, but all turned out not to be plague. One of these, a female, æt. 16, who died suddenly after a few days' illness, furnished good grounds for suspicion, but the *post mortem* examination disproved this.

CLINICAL FORMS.

17. In 13 of the 14 cases, buboes were present; the remaining case was septicæmic in type. The buboes were situated in the following regions :—Right inguinal, 4; left inguinal, 1; right femoral, 1; left femoral, 5; left axillary, 2. In each case a single gland was involved.

MODE OF ONSET.

18. This was sudden in every one of the 14 cases. The patient could definitely state the time of the onset of his first symptoms. These in 7 instances consisted of headache associated with shivering, in 7 there was vomiting, and in almost all cases, within a few hours after the onset of these symptoms, and often accompanying them, pain was experienced in that glandular region which subsequently presented a definite bubo.

SEX INCIDENCE.

19. All the 14 patients were males.

AGE INCIDENCE.

20. Seven cases were at age period 15–20, 3 at period 20–30, 1 at period 30–40, and 3 at period 40–50 years.

FATALITY.

21. Of the 14 cases, 3 proved fatal. The ages of the fatal cases were 16, 17, and 44 years respectively. The fatality rate of the 14 cases was 21·4 per cent. Of the fatal cases, 2 were bubonic and 1 septicæmic. One death occurred 8 days after the onset of illness, and 5 days after coming under treatment in hospital; the second death (septicæmic plague) occurred on the fifth day after the patient fell ill; and the third death occurred 3 days after attack, and 2 days after admission to hospital.

SERUM TREATMENT.

22. Yersin's anti-pest serum was used in the treatment of 10 of the 14 cases. It was given subcutaneously in all instances. The quantity injected in individual cases varied considerably, the amount and frequency of dosage being determined by the gravity of the case. The maximum amount used in any case was 944 c.c., and the minimum, 50 c.c. Urticarial eruptions and joint pains followed the use of the serum, and were very marked in those cases where the dosage was high. The number of cases are far too few to enable a correct judgment to be formed, but the serum treatment appeared to be of considerable value, and in the 2 cases with axillary buboes, both very severe attacks, it probably helped very largely in averting a fatal issue.

RELATION BETWEEN SUCCESSIVE CASES.

23. The following facts were ascertained :—

Case B lived on premises adjoining and in direct communication with those at which Case A worked, and where A is credited with having received his infection, but B did not know A, nor did he visit the premises at which A worked.

Case C worked at the same factory as Case N (date of attack of C, 28th March, 1905; that of N, 2nd July, 1905), but they were employed in different parts of this establishment, which is a very large one, employing about 700 hands, and they were not associates, nor did they know each other, except by sight.

Case D lived in the same part of the city as Cases A and C (their residences being separated from each other by about 200 yards), but he did not associate with either of them, nor visit their residences.

Case E worked at the same produce store as case A, but in a separate, detached part of it (date of attack of A, 22nd March, 1905; that of E, 22nd April, 1905. They were known to each other, but were not associates, nor did they visit each other's homes.

Case F performed the *post mortem* examination on Case E, and was inoculated through a small abrasion of the left forefinger, made during the *post mortem*.

Case G (date of attack, 3rd May, 1905) worked at stables in a yard adjoining, and had to pass through part of the same premises where Cases H (date of attack, 5th May, 1905) and I (date of attack, 11th May, 1905) were employed. He did not associate with either of them.

Cases H and I (date of attack of H, 5th May, 1905; that of I, 11th May, 1905) were employed on the same premises, and ceased work on the dates on which they were attacked. They did not associate together, nor visit each other's homes.

Cases J, K, L, and M were not known to each other, or to any of the other cases, nor did they frequent the same premises.

24. It amounts to this, then, that on one premises, employing 35 persons, 2 cases occurred, with an interval of four weeks and three days between the two cases. At a second premises, 2 cases occurred amongst the 700 hands employed, with an interval of fourteen weeks between the cases. At a third premises, employing 9 persons, 2 cases occurred, with an interval of six days between the cases. In these, as well as in the remaining 7 cases (Case F excluded), there was no evidence to support the view that the infection was conveyed from one person to the other. As will be seen later on, the outstanding factor common to the whole of the 13 cases was the association of plague-infected rats at their residence or place of employment.

PLAGUE IN RATS IN RELATION TO THE EPIDEMIC.

25. On the discovery of the first case of plague in man, steps were taken to provide for the destruction of rats in the city and district. A staff of four experienced rat-catchers sent by the Department of Public Health was employed to procure rats for examination from all parts of the city. At the same time the municipal local authority notified the general public, by handbills and posters throughout the city and district, of the necessity of taking steps to destroy rats about their premises. The rat incinerator in Merewether-street was started, and a bonus of 3d. per rat and 1d. per mouse was paid for all rodents brought to the incinerator.

26. Between 28th March and 14th August, 1905 (the dates of the opening and closing of the incinerator, respectively), 13,901 rodents were destroyed. Of this total, 12,191 were rats and 1,710 mice. Of the total, 2,391 were procured by the rat staff, consisting of four men.

27. Of the 13,901 rodents brought to the incinerator, 6,653 (including the 2,391 procured by the staff) were examined for plague, and 206 of them were definitely proved to be infected with the disease. It should be stated that a large number of the rodents brought for examination were too far advanced in decomposition to enable a definite decision to be formed as to the cause of their death, though it was in all probability due to plague, for it not infrequently happened that one or more of a batch found on the same premises were plague infected, whilst the remainder were too decomposed to allow of a prompt and definite decision being arrived at, though the indications pointed to plague having been the cause of their death. Leaving this out of account, however, it is still found that 3 per cent. (206 out of 6,653) of the rodents examined were plague infected. This is a considerably higher proportion than has hitherto been found in this State.

28. The percentage of the several species amongst the total (6,653) rodents examined during the period 28th March to 14th August, 1905, was—*Mus musculus*, 11·1 per cent.; *Mus rattus*, 22·2 per cent.; and *Mus decumanus*, 66·7 per cent.

29. Of the 206 plague-infected rodents, 171 were *Mus decumanus*, 22 *Mus musculus*, and 13 *Mus rattus*. They thus respectively constituted 83, 10·6, and 6·3 per cent. of the total found infected.

30. The last case of plague in the epidemic was notified on 4th July (date of attack, 2nd July); the last plague-infected rat was taken on 6th July. Between 6th July and 14th August, when the incinerator was closed, 594 rats from different parts of the city were examined, but they were all found to be healthy.

31. There was no evidence that ordinary domestic animals suffered from the disease. Five domestic cats in a sickly condition were submitted for examination, but they were all found not to be suffering from plague.

32. The different species of plague-infected rats found at the credited place of infection of the 13 plague cases are set out in the following table (Dr. J.R.L., Case F, is omitted):—

Credited place of infection.	Species of infected rodents found at such credited place of infection.
	Case A.
Employment (produce store).	M. *decumanus*, M. *musculus*
	Case B.
Residence	Putrid rodents only. Premises adjoined and in direct communication with those on which Case A worked.
	Case C.
Residence	M. *decumanus*.
	Case D.
Employment (marine store).	M. *decumanus*.
	Case E.
Employment (produce store).	*M. decumanus*, M. *musculus*.
	Case G.
Employment (stables).	M. *decumanus*.
	Case H.
Employment (butcher's shop).	M. *decumanus*.
	Case I.
Employment (butcher's shop and stables).	M. *decumanus*.
	Case J.
Employment (grocery store).	M. *decumanus*, M. *rattus*, M *musculus*.
	Case K.
Employment (restaurant).	M. *decumanus*.
	Case L.
Residence	No rodents on premises, but M. *decumanus* in stables at rear.
	Case M.
Employment (stables).	M. *decumanus*.
	Case N.
Not determined ...	None at residence or employment. M. *decumanus* at ferry wharf frequented by patient.

33. Thus, where plague-infected rodents were found on the credited places of infection, *Mus. decumanus* was the species concerned in each instance, *M. musculus* in association with it in three instances, and *M. rattus* in association with *M. decumanus* and *M. musculus* in one instance.

34. The following table shows the number of rodents examined week by week from the beginning of the epidemic down to 14th August, together with the percentage of rats found plague-infected amongst those examined :—

Week ending—	Rodents examined.	Plague infected.		Human cases notified.
		Number.	Percentage.	
April 1 ...	300	10	3·3	3
„ 8 ...	310	14	4·5	1
„ 15 ...	275	4	1·4	...
„ 22 ...	314	17	5·4	...
„ 29 ...	279	9	3·2	1
May 6 ...	646	23	3·5	3
„ 13 ...	664	20	3·0	1
„ 20 ...	616	42	6·8	...
„ 27 ...	729	33	4·5	3
June 3 ...	518	22	4·2	...
„ 10 ...	393	2	·50	1
„ 17 ...	454	7	1·5	...
June 24 ...	209	...	......	...
July 1 ...	163	1	·61	...
„ 8 ...	245	2	·81	1
„ 15 ...	143	0	......	...
„ 22 ...	78	0	......	...
„ 29 ...	118	0	......	...
Aug. 5 ...	122	0	......	...
„ 12 ...	44	0	......	...
„ *19 ...	33	0	......	...
Totals ...	6,653	206	3·0	14

* Incinerator closed 14th August.

35. Though more than 2,500 rats caught in the suburbs of Newcastle were examined, only 5 were found to be infected with plague. The circumstances surrounding these rats deserve mention, as they were the only plague-infected rodents discovered outside the boundaries of the City of Newcastle. Four of these ats were taken from a garbage tip in the municipality of Wickham. This tip is located on the foreshores of a creek which discharges into the harbour at a point distant about 1½ miles from the city boundaries. The sources of infection in this locality may be explained in this way :—Two cartloads of refuse from the butcher's shop in Hunter-street West, Newcastle, at which Cases H and I worked, and where

many plague-infected rats were taken, were carted surreptitiously at the dead of night by some of the employees of this firm, and deposited at this tip. (The culprits were seen doing this, were prosecuted, convicted, and fined £4, the maximum penalty allowed by the by-law under which the proceedings were taken, or two months' gaol.) This happened on 6th May, 1905; 4 plague-infected rats were discovered at this tip between 12th June, 1905, and 15th June, 1905.

36. In the only other instance where plague-infected rats were found outside the Newcastle boundary occurred in the feed-room attached to a stable in Wickham. It was ascertained that about fifty bags of chaff had been received from the produce store connected with the merchant's premises in Bond-street, Newcastle, at which plague-infected rats were discovered on 9th May, 1905. One plague-infected rat was taken in the feed-room referred to on 31st May, 1905, and on overhauling the premises on 1st June, 1905, 6 other carcases of rats were discovered, but they were too putrid for examination

37. Between 28th March and 6th July, 162 of the total 206 plague-infected rats were taken from 49 premises; and of the remainder, 41 came from the foreshores and under the wharves lining the harbour, and 3 from an open sewer in Cook's Hill. Infected rats were discovered along the wharves as early as 2nd April, and the last plague-infected rodent taken, namely, on 6th July, came from the same locality.

38. Of the 49 premises on which plague rats were found, 15 stables yielded 37 rats; 8 produce stores yielded 37 plague rats; 2 fish shops, 23 rats; 1 photographer's, 19 rats; 2 bakers, 10; 4 hotels, 11; 1 butcher's, 4; 1 marine store, 2; 2 ship-chandlers, 2; 3 restaurants, 3; whilst 10 premises in private occupation yielded, 14 plague rats. The 10 premises last mentioned were situated in close proximity to, and in many cases abutted on, produce stores, stables, or one or other of the business premises referred to above, and it seems most likely that the infected rats found on them were members of the company infesting the neighbouring premises.

39. Consideration of the subject of plague in rats, and its relation to plague in man, shows on the one hand that at 41 different premises in the city (excluding the wharves) which yielded plague rats, no cases of plague occurred amongst the occupants or employees of any of these premises. A premises may apparently be grossly infested by plague rats, and yet no case occur amongst the inmates of those premises. A striking instance of this is furnished in the case of three adjoining premises in Hunter-street. In the cellars of a fish shop, a hotel, and a photographer's premises adjoining one another, no less than 43 plague-infected rats and a number of putrid carcases of rats were discovered between the 15th May, 1905, and 2nd June, 1905, during cleansing operations, but no case of plague preceded, accompanied, or followed amongst the inmates of any of these premises. On the other hand, in the 13 cases of plague (Case F excluded), infected rats were discovered at the residence or place of employment of 11 out of the 13 cases. As regards the remaining 2 cases, plague-infected rats to the number of 14 were taken between the 2nd May, 1905, and 22nd May, 1905, on stable and other premises immediately at the rear of the residence of one of them (Case L, date of attack, 29th May, 1905), whilst in the remaining case (Case N, date of attack, 2nd July, 1905) no plague-infected rats were found either at his residence or place of employment, but at the ferry wharf, which he frequented on the Newcastle side of the harbour, 12 plague-infected rats were taken between 2nd April, 1905, and 6th July, 1905.

40. The experiences above described coincide with those met with in plague epidemics in other parts of this State.

ORIGIN OF THE INFECTION.

41. Little consideration need be given to the question as to whether the disease was introduced into Newcastle by means of ships from plague-infected places, in other parts of the world. The ports which perhaps should be mentioned in this connection are Hong Kong, Mauritius, and those in South Africa. Now, vessels arriving in Newcastle from these places are, almost without exception, in ballast. Ships coming foreign to Newcastle, from infected ports, are subjected to fumigation with sulphur by the Port Health Officer's staff, and, as they are as a rule in ballast, this procedure can be and is carried out with great success as regards the destruction of rats. Never at any time has there been a history of plague infection in man or rats on board any ship reaching Newcastle from any foreign port.

42. Newcastle is in daily communication with Sydney by rail and sea, the trade between the two cities being very considerable by both routes. Frequent communication is maintained by sea between Newcastle and the northern ports in this State, as well as with Brisbane and other ports in the adjoining State of Queensland.

43. Epidemics of plague were experienced in Sydney during 1900 and 1902, and occasional cases occurred in 1901, 1903, and 1904; whilst plague-infected rats were found there, especially about the harbour frontages, during each succeeding year since 1900.

44. In Brisbane, Queensland, plague has not been absent since 1901.

45. The following table shows the state of affairs as regards human and rat plague in those places with which direct trade relations existed with Newcastle for the few months preceding the occurrence of the first case of plague in this city:—

Sydney. December, 1904—March, 1905.		*Northern Ports of New South Wales.* December, 1904—February, 1905.		*Brisbane, Queensland.* 2 January—9 March, 1905.	
Cases in		Cases in		Cases in	
Rats.	Man.	Rats.	Man.	Rats.	Man.
12	2	124	13	90	22

46. Now, there has been no positive evidence that plague in rats or man reached Newcastle by means of vessels trading with any of the above-mentioned places. In this connection it should be pointed out that the practice pursued by the authorities in Australasia during the past four years, so soon as plague was discovered in rats or man in any port, included the following—the fending of vessels off wharves, the provision of discs on the moorings, unloading into lighters in the stream of all fodder, the fumigation of ships' holds and other parts, when empty, by means of sulphur. These procedures had for their object the limitation, as far as possible, of the transportation of infection by means of rats.

47. But these precautions cannot be absolutely relied upon to secure freedom of infection of a clean from an infected port, for their enforcement takes place only after plague has been discovered in rats or man. Now, it has been proved over and over again, at least in Australia, that by the time the first evidence of plague is discovered in the rats of a particular place, on search being made, widespread invasion of the rat tribe is found to have already occurred, and evidence is usually not wanting to show that the infection has been in existence for a considerable time prior to the discovery of the first infected rodent. Thus many opportunities may have existed for the transportation of infection by means of rats before any steps have been taken to prevent it.

48. As bearing on the question of the possibility of the transport of infected rats and the maintenance of the infection amongst the rat tribe on board ship for several weeks, reference may be made to the case of the "Antillian s.s." (Report of the Board of Health on the Sydney Plague Outbreak, 1902, by Dr. Ashburton Thompson, pars. 50-64), where, after a voyage from Cape Town, lasting 29 days, the vessel arrived in Sydney with rats still alive and actually suffering from plague at the time of her arrival.

49. All that can be definitely stated in reference to the source of infection of the Newcastle outbreak is this: At several State and inter-State ports with which Newcastle was in direct and frequent communication by sea, as well as by land, cases of plague in rats and man existed for several months prior to the occurrence of the first case of plague in Newcastle; that produce and other goods were shipped direct from these ports to produce stores in Newcastle; that, after the notification of the first case of plague, on 25th March, search of the produce store at which the patient worked resulted in the finding of a number of plague-infected rats, and the carcases of a large number of dead and putrid rats which had apparently succumbed some weeks previously. That similar conditions, as regards rats, were met with on other premises in the city. That as soon as search was made, plague-infected rats were found about the wharves, where vessels from the places referred to in the above table lay, and infected rats continued to be taken about these wharves down to 6th July, 1905.

50. The inference drawn from these circumstances is, that the infection was transported to Newcastle, either by produce infected by means of plague rats, and conveyed from it to the local rats, or, what is much more probable, that rats were transported, and landed at Newcastle, and, in turn, communicated the disease to the local rodents, and from them it was conveyed in some, as yet imperfectly explained, manner to human beings.

51. The possibility of the transportation of infection by ambulant or unrecognised cases of human plague coming from the centres of infection in New South Wales and Queensland is so remote as not to need consideration, and may be dismissed as having no bearing on the question.

MEASURES TAKEN IN SUPPRESSION OF THE EPIDEMIC.

52. The Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.) was directed to examine and confirm the diagnosis of the two first cases of the disease and to confer with me, and, later, that officer relieved me for two days on 6th and 7th May, during slight indisposition.

53. The President of the Department of Public Health (Dr. J. Ashburton Thompson) visited the city during the course of the epidemic and advised the Mayor of the city (Alderman M. J. Moroney) on important matters, which received prompt attention at his hands. At the same time the President was able to give able counsel and advice in regard to many matters in connection with the work of control of the epidemic.

54. The measures taken in the suppression of the epidemic followed in detail those so successfully employed in Sydney during the past four years, and they included the following:—

1. *As regards the patients.*—On receiving a notification of a case of plague, I visited the patient, confirmed the diagnosis (by the bacteriological methods referred to under the various cases at the beginning of the Report) and if not already in hospital, arrangements were made for his removal there by ambulance. With the exception of Case E, who died at his residence, all the patients were treated in the isolation wards of the Newcastle Hospital. The Department of Public Health sent up two trained nurses who had had previous experience in the nursing of plague patients, and they were assisted by the hospital nursing staff as occasion arose. The treatment of the patients devolved upon the honorary medical staff and resident medical officer of the hospital.
2. *Residences of patients.*—The procedure depended upon whether rodents were in evidence in and about them or not. Where the residence of the patient was deemed the place of infection (determined by finding plague-infected rodents upon them), the premises were thoroughly overhauled with the object of ridding them of rats, and were disinfected in detail. Where there was no evidence that the residence was the place of infection, then the bedroom occupied by the patient prior to his removal to the hospital was alone disinfected.
3. *Place of employment of patients.*—When deemed the place of infection, as it was in 9 of the 13 cases, the premises were thoroughly overhauled and disinfected. This, in the case of produce stores, involved a great amount of labour, and occupied considerable time. All stocks were turned over, torn and rat-eaten bag stuff destroyed, double partitions removed, wooden floors taken up, and the whole premises cleared of litter, cleansed, and disinfected. Careful search was made for rats, and active steps taken for their destruction. This detailed work of cleansing, disinfection, &c., was not confined to the particular premises on which the patient worked, but was extended so as to include all the adjoining premises which were found to be in direct communication with the infected building.
4. When plague was identified in rodents taken from any premises by the rat staff, or brought in by the public, steps were taken to overhaul, cleanse, and disinfect the premises, search for rats, &c., on the same lines as mentioned in the preceding paragraph.

5. Then followed the overhaul of successive blocks of buildings in the city, attention being given by the staff to the cleansing of premises, destruction of rats, and the removal of materials likely to harbour rats. On the plan of the city in the Appendix, the blocks which were dealt with in this way are edged with blue.
6. The rat incinerator was started in Merewether-street, Newcastle, and a bonus of 3d. per rat and 1d. per mouse was paid for all rodents brought there. The amount paid in this way was £172 16s. 4d. for 11,510 rodents. The working expenses of the incinerator from 28th March to 14th August, 1905, amounted to £42 4s. 11d.
7. A rat staff of four experienced men, detailed by the Department of Public Health, procured 2,391 rodents for examination from different parts of the city, and they did good work in the search for and destruction of rats during the overhaul and cleansing of various premises.
8. I undertook the systematic examination of rodents brought to the incinerator by the public, and those procured by the rat staff from 28th March to 2nd May inclusive. From that date down to 17th June, 1905, an assistant (Mr. G. G. Grant) from the laboratory of the Department of Public Health carried it on, then I resumed the work until 14th August, when the incinerator was closed down.
9. The City Council, by handbills and posters, urged the residents to destroy rodents about their premises. Free distribution of rat poison was made to the public. The authorities in charge of the various wharves in the district had poisoned baits systematically laid about the wharves and foreshores. The Government issued a proclamation, which was posted about the district, drawing attention to the fact that failure on the part of any person to notify to the proper authorities the fact of unusual mortality amongst rats about their premises, rendered them liable to prosecution for misdemeanour.

55. In connection with the cleansing work undertaken on the notification of the first four cases of plague, the Department of Public Health sent the Chief Sanitary Inspector (Mr. P. Getting, F.I.S.E.) to Newcastle to act under me in assisting the Sanitary Inspector of the city (Mr. T. Lloyd, Cert. R. San. Inst.) in the supervision of the work. Later on, the same Department despatched one of their experienced quarantine officers to act as ganger in charge of a number of the men performing cleansing work. The cleansing and overhaul of those portions of the city edged in blue on the map was spread over the period 28th March to 4th July, 1905.

56. The members of the Newcastle City Council are worthy of commendation for the prompt manner with which they dealt with the various matters brought under their notice, and in supplying the necessary labour and appliances requisite to enable cleansing operations to be carried out promptly and thoroughly; whilst the Mayor of the city (Alderman M. J. Moroney) is deserving of special praise for the thorough and fearless manner in which he acted on the advice and recommendations of his officers.

57. Special mention should be made of the ceaseless energy and invaluable assistance rendered by the Sanitary Inspector of the city (Mr. T. Lloyd, Cert. R. San. Inst.), whilst the Sanitary Inspector attached to my staff (Mr. J. Abberton, Cert. R. San. Inst.) and other officers rendered able service.

ROBERT DICK,
Medical Officer of Health to the Hunter River Combined Sanitary Districts.

[One Plan.]

CODE

CODE OF BY-LAWS ADOPTED BY THE NEWCASTLE MUNICIPAL COUNCIL FOR THE BETTER PREVENTION OF THE SPREAD OF PLAGUE BY MEANS OF RATS.

Published in Government Gazette No. 360, *of* 14*th July*, 1905.

Chief Secretary's Office, Sydney, 11 June, 1905.

NEWCASTLE MUNICIPALITY—BY-LAWS.

THE following By-laws made by the Council of the Borough of Newcastle, under the provisions of the "Municipalities Act, 1897," having been confirmed by His Excellency the Lieutenant-Governor, with the advice of the Executive Council, are published in accordance with the requirements of the above-cited Act.

J. A. HOGUE.

Borough of Newcastle—By-laws under the provisions of the Municipalites Act, 1897.

1. The owner of any produce store, hay store, butcher's shop, bakery or pastrycook or baker's small goods bakery, or butcher's small goods shop in the municipality, the floors of which are of such material, or so constructed, or in such a state as to permit the harbouring of rats in or about such store, shall, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such floors to be so reconstructed or constructed of concrete not less than four inches in thickness, or other approved material impervious to rats, and shall so repair, alter, reconstruct or protect skirting boards, partitions, doors, ventilation, or other openings in the walls or elsewhere of such produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about it.

2. The owner of any premises within the municipality who, after the passing of these by-laws, shall construct or let any building therein for the purpose of a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, or who shall convert any building therein to the purpose of a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, shall, upon such construction, letting, or conversion, as the case may be, cause the floors thereof to be constructed of concrete not less than four inches in thickness, or other approved material impervious to rats, and he shall so construct, alter, repair, reconstruct, or protect skirting boards, partitions, doors, ventilation, or other openings in the walls or elsewhere, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about such premises.

3. The owner of any building, other than a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop in the municipality which is in such a condition as to permit the access of rats to, or the harbourage of rats in it, and whether such condition be in the structure, or in the openings in it, or in the doors or ways of entrance to it, or in its floors, skirting boards, ceilings, partitions, or the like internal fittings within it, shall, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such building to be so repaired, or as regards its doors or ways of entrance, and its floors, skirting boards, ceilings, partitions, and the like internal fittings within it, to be so altered or repaired as to prevent, as far as practicable, access of rats to it and harbourage of rats within it.

4. The owner or occupier of any premises within the municipality, with which is connected any area grating, or in the external walls of which is any other opening of such a nature as to permit the entry of rats thereto, shall, within fourteen days of service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such area grating and such other openings to be covered with wire netting of such a mesh, and in such a manner, as to prevent the entry of rats through them.

5. The owner or occupier of any stable, cow-yard, cattle-shed, piggery, or pig-shed within the municipality now constructed, shall cause to be paved, flagged, or floored with concrete not less than four inches in thickness, or other approved material impervious to rats, and to be completely and well drained, and to have proper sewer connections where available, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do.

6. The occupier of such premises shall, upon production of the notice served upon the owner as aforesaid, allow the owner and his workmen free access thereto, for the purpose of enabling him and them to comply with the terms of the preceding by-laws.

7. The owner or occupier of any premises within the municipality who shall, after the passing of these by-laws, construct a stable, cow-yard, cattle-shed, or pigsty therein, or convert any building therein into a stable, cow-yard, cattle-shed, or pigsty, shall cause the same to be paved or floored with concrete not less than four inches in thickness, or other approved material impervious to rats, to be completely and well drained, and to have proper sewer connections where available.

8. The owner or occupier of any stable, cow-yard, cattle-shed, or pigsty within the municipality shall, within one month of the service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause any feed-store connected with such stable, cow-yard, cattle-shed, or pigsty to be floored with concrete not less than four inches in thickness, or other approved material impervious to rats, and shall so reconstruct, repair, or alter any floor, wall, and any ceiling or partition within it, as may be directed, so as to prevent the harbourage of rats therein, and shall protect all openings in the external walls thereof, as may be directed, so as to prevent the access of rats thereto.

9. The occupier of any premises in the municipality which contain any stable, cow-yard, cattle-shed, or pigsty shall provide a bin for the reception of all dung or refuse arising in such stable, cow-yard, cattle-shed, or pigsty, built of brick or other impervious material; if of brick, must be not less than 4½ inches brickwork floated on all internal parts, with at least half an inch good clean cement, and shall cause such stable, cow-yard, cattle-shed, or pigsty to be cleansed daily; and all manure, dung, or other refuse arising in or in connection therewith, if not removed from the premises immediately, to be placed in such bin, and shall cause the said bin to be kept covered, and to be emptied and cleansed, and its contents to be removed from the premises, at least *once* every week, or oftener if necessary, and shall not at any time allow such bin to be or to remain a nuisance.

10. No person shall place or throw, or suffer to remain, any refuse on any premises in the municipality in such a manner or for such a time as to encourage rats or other vermin to visit or frequent such premises.

11. Every occupier of premises in the municipality shall, within seven days of service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, provide a sufficient number of receptacles of rigid metal, cylindrical in shape, and provided with two side handles, and each of a capacity not exceeding 2 cubic feet, for the reception of the garbage and refuse arising upon such premises.

12. Every such occupier shall provide all refuse and garbage receptacles in use on such premises with a cover fitting as closely as practicable.

13. Every such occupier shall cause such receptacles to be continuously covered, save when garbage or refuse is being deposited in or discharged from them.

14. Every such occupier shall cause all refuse or garbage receptacles in use on his premises, and the covers thereof, to be kept as clean as practicable, and maintained in good order and condition.

15. Every such occupier shall cause all garbage and refuse from time to time arising from such premises to be forthwith deposited in such receptacle.

16. Every such occupier, between such hours and such days as may be prescribed by the notice served upon him, and purporting to be signed by an officer of the Council, shall cause such receptacles to be placed in such a position on such premises as to be within six feet of the gateway or entrance from the street abutting on such premises, which is traversed by any vehicle employed by the Council in the collection of garbage and refuse, and so as to be conveniently accessible to the persons employed by the Council in the collection and removal of garbage and refuse. Provided that, if by reason of conformation of the premises, it shall not be practicable to comply with the requirements of this by-law, and such occupier shall cause such receptacles to be placed on the outer edge of the footway in such street between the hours and days as aforesaid, he shall not be guilty of any offence against this by-law.

17. No person other than a workman employed by the Council in the collection of garbage and in street cleansing shall interfere with, disturb, or remove any garbage receptacles for the time being in any street, nor the contents of any such receptacle.

18. The owner of any premises within the municipality shall, within one month of service of a written notice purporting to be signed by an officer of the Council, cause the floor of any water-closet and of any pail closet, situated wholly or in part outside the walls of the dwelling portion of the premises, to be constructed of good cement concrete not less than four inches in thicknesss, and to be so laid that it shall be in every part thereof at a height of not less than six inches above the level of the ground adjoining such closet, and so that the said floor may have a fall or inclination from the rear of the closet towards the door of entrance of not less than one half-inch to the foot, and the riser enclosing the space beneath the seat (if any) to be removed in the case of a water-closet, and in the case of a pail closet, to be well-fitted to the seat, and to extend downwards not more than four inches from the underside of the seat.

19. In construction of these by-laws, the words "produce store" shall mean any building, or portion of a building, wherein wheat, oats, barley, maize, pollard, bran, hay, lucerne, chaff, flour, or vegetables is deposited or kept exposed for sale, and with regard to other words a similar construction shall be applied as the Interpretation Act No. 4, 1897, provides for the interpretation of Acts of Parliament.

Definition of Owner.

20. In the construction of these by-laws, the word "owner" shall mean the person for the time being receiving the rent of the premises in connection with which the word is used, whether on his own account, or as agent or trustee for any other person, or who would receive the same if such premises were let at a rent.

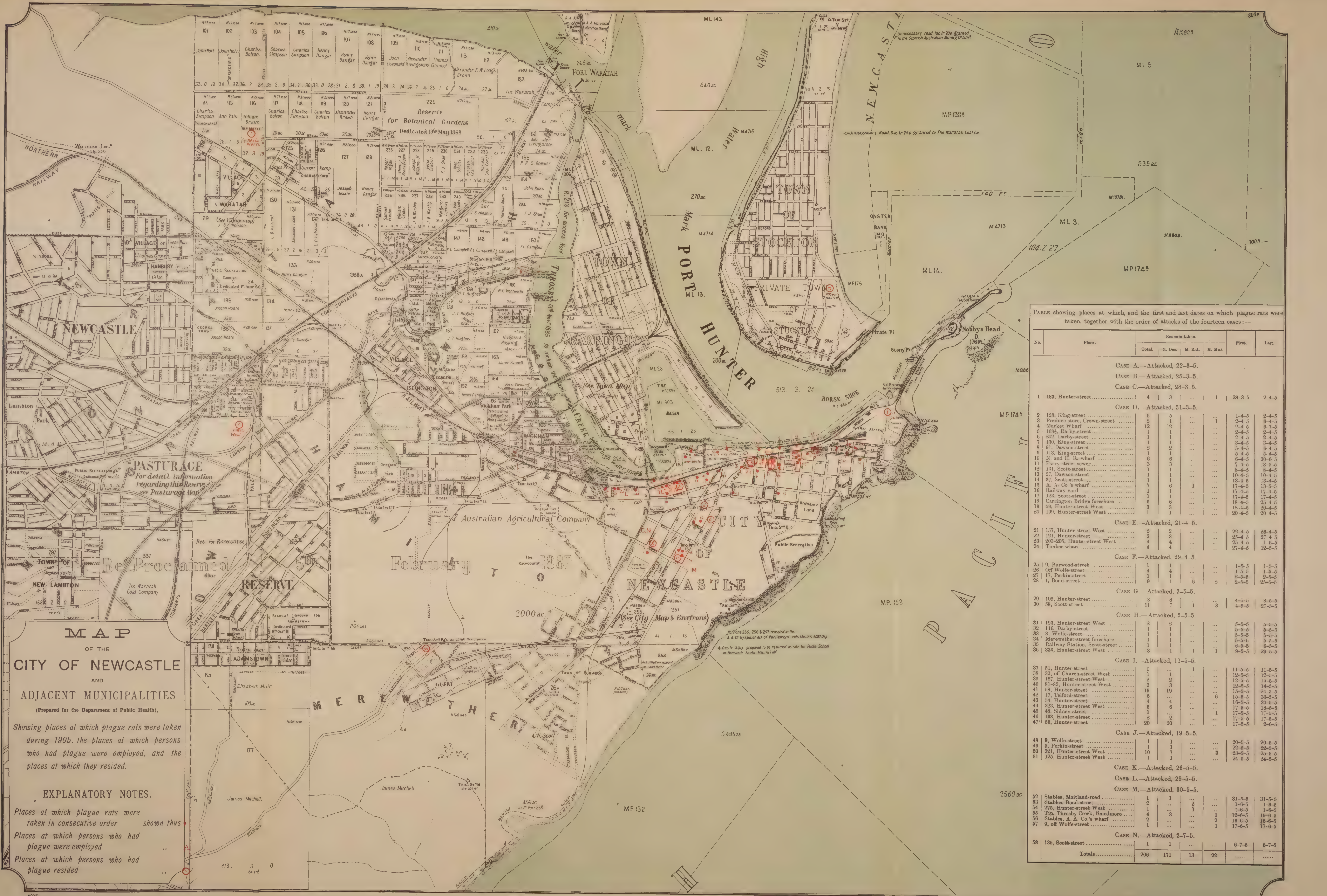
21. Any person offending against any of the above by-laws shall for each offence upon conviction forfeit and pay a sum not exceeding ten pounds, and shall be further liable to a penalty of one pound for each and every day the offence is continued after notice, provided that no penalty or penalties shall exceed fifty pounds.

Made and passed by the Council of the Borough of Newcastle, this twelfth day of June, in the year of our Lord one thousand nine hundred and five.

(L.S.) M. J. MORONEY,
Mayor.

E. Scott Holland,
Town Clerk.

APPENDIX A.



MAP

OF THE

CITY OF NEWCASTLE

AND

ADJACENT MUNICIPALITIES

(Prepared for the Department of Public Health),

Showing places at which plague rats were taken during 1905, the places at which persons who had plague were employed, and the places at which they resided.

EXPLANATORY NOTES.

Places at which plague rats were taken in consecutive order	*shown thus* ● 1
Places at which persons who had plague were employed	,, A
Places at which persons who had plague resided	,, ⓤ

Table showing places at which, and the first and last dates on which plague rats were taken, together with the order of attacks of the fourteen cases:—

No.	Place.	Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
	Case A.—Attacked, 22-3-5.						
	Case B.—Attacked, 25-3-5.						
	Case C.—Attacked, 28-3-5.						
1	183, Hunter-street	4	3	...	1	28-3-5	2-4-5
	Case D.—Attacked, 31-3-5.						
2	128, King-street	5	5	...	...	1-4-5	2-4-5
3	Produce store, Crown-street	2	1	...	1	2-4-5	6-4-5
4	Market Wharf	12	12	...	...	2-4-5	6-7-5
5	168½, Darby-street	1	1	...	...	2-4-5	2-4-5
6	202, Darby-street	1	1	...	...	2-4-5	2-4-5
7	130, King-street	1	1	...	...	3-4-5	3-4-5
8	91, Dawson-street	2	2	...	...	5-4-5	6-4-5
9	113, King-street	1	1	...	...	5-4-5	5-4-5
10	N. and H. R. wharf	6	6	...	...	6-4-5	30-6-5
11	Parry-street sewer	3	3	...	...	7-4-5	18-5-5
12	131, Scott-street	1	1	...	...	8-4-5	8-4-5
13	27, Dawson-street	1	1	...	...	10-4-5	10-4-5
14	37, Scott-street	1	1	...	...	13-4-5	13-4-5
15	A. A. Co.'s wharf	7	6	1	...	17-4-5	13-5-5
16	Railway yard	1	1	...	...	17-4-5	17-4-5
17	123, Scott-street	1	1	...	...	17-4-5	17-4-5
18	Carrington Bridge foreshore	6	6	...	...	18-4-5	25-4-5
19	59, Hunter-street West	3	3	...	...	18-4-5	20-4-5
20	199, Hunter-street West	1	1	...	...	20-4-5	20-4-5
	Case E.—Attacked, 21-4-5.						
21	157, Hunter-street West	2	2	...	...	22-4-5	26-4-5
22	121, Hunter-street	3	3	...	...	25-4-5	27-4-5
23	203-205, Hunter-street West	4	4	...	...	25-4-5	1-5-5
24	Timber wharf	4	4	...	...	27-4-5	12-5-5
	Case F.—Attacked, 29-4-5.						
25	9, Burwood-street	1	1	...	...	1-5-5	1-5-5
26	Off Wolfe-street	4	4	...	...	1-5-5	1-5-5
27	17, Perkin-street	1	1	...	...	2-5-5	2-5-5
28	1, Bond-street	9	1	6	2	2-5-5	25-5-5
	Case G.—Attacked, 3-5-5.						
29	109, Hunter-street	8	8	...	...	4-5-5	8-5-5
30	58, Scott-street	11	7	1	3	4-5-5	27-5-5
	Case H.—Attacked, 5-5-5.						
31	193, Hunter-street West	2	2	...	...	5-5-5	5-5-5
32	116, Darby-street	1	1	...	...	5-5-5	5-5-5
33	8, Wolfe-street	1	1	...	...	5-5-5	5-5-5
34	Merewether-street foreshore	1	1	...	...	5-5-5	5-5-5
35	Railway Station, Scott-street	1	1	...	...	6-5-5	6-5-5
36	333, Hunter-street West	3	1	1	1	9-5-5	29-5-5
	Case I.—Attacked, 11-5-5.						
37	51, Hunter-street	1	...	1	...	11-5-5	11-5-5
38	32, off Church-street West	1	1	...	...	12-5-5	12-5-5
39	167, Hunter-street West	2	2	...	...	12-5-5	14-5-5
40	81-83, Hunter-street West	3	3	...	...	12-5-5	14-5-5
41	58, Hunter-street	19	19	...	...	15-5-5	24-5-5
42	17, Telford-street	6	...	...	6	15-5-5	30-5-5
43	54, Hunter-street	4	4	...	...	16-5-5	30-5-5
44	323, Hunter-street West	6	6	...	...	17-5-5	18-5-5
45	48, Sidney-street	1	...	...	1	17-5-5	17-5-5
46	133, Hunter-street	2	2	...	...	17-5-5	17-5-5
47	56, Hunter-street	20	20	...	...	17-5-5	2-6-5
	Case J.—Attacked, 19-5-5.						
48	9, Wolfe-street	1	1	...	...	20-5-5	20-5-5
49	5, Perkin-street	1	1	...	...	22-5-5	22-5-5
50	321, Hunter-street West	10	7	...	3	23-5-5	25-5-5
51	125, Hunter-street West	1	1	...	...	24-5-5	24-5-5
	Case K.—Attacked, 26-5-5.						
	Case L.—Attacked, 29-5-5.						
	Case M.—Attacked, 30-5-5.						
52	Stables, Maitland-road	1	1	...	...	31-5-5	31-5-5
53	Stables, Bond-street	2	...	2	...	1-6-5	1-6-5
54	275, Hunter-street West	1	...	1	...	1-6-5	1-6-5
55	Tip, Throsby Creek, Smedmore	4	3	...	1	12-6-5	15-6-5
56	Stables, A. A. Co.'s wharf	2	...	...	2	16-6-5	16-6-5
57	9, off Wolfe-street	1	...	...	1	17-6-5	17-6-5
	Case N.—Attacked, 2-7-5.						
58	135, Scott-street	1	1	...	...	6-7-5	6-7-5
	Totals	206	171	13	22	......	......

67710

Photo-lithographed by
W. A. Gullick, Government Printer,
Sydney, N.S.W.

APPENDIX A.

The following are the more important of the forms which have been used in connection with the investigation of Plague :—

No. 1. Form No. 317.

DEPARTMENT OF PUBLIC HEALTH, N.S.W.

Plague. **Visiting Medical Officer's Report.** **Case No.**

Notified by on 19 , at m.
Visited by on 19 , at m.
Diagnosis (1) Plague. Clinical form

Name Age , Sex , condition
Residence
Employment, place of
Nature of
Last attendance at
Where found
Reported for removal to Hospital on at m.
Clinical account. Illness began on at m.,
and had a (2) onset. First symptom
History previous to examination :—

Bubo of region, first noticed on
19 , at .m. Progress
Condition on examination. T. P. R.
Bubo
Specimen taken . Result of Smears
Lesions of drainage area of Bubo
Previous attacks at on 19 .
Previously inoculated at on 19 .
Present inoculation, Haffkine fluid ccm, on 19 .
serum, ccm, on 19 .
Relation to previous patients
Relation to infected articles
Relation to Dead or Sick rats
Movements for 10 days previous to attack
Contacts—
At Residence

Name.	Inoculated (Date.)	Haffkine (Quantity.)	Serum (Quantity.)

At employment as by list attached.
Illness amongst
Plague amongst

Form

[1] If necessary insert "not."

[2] Insert sudde or gradual.

No. 2. Form No. 320.

DEPARTMENT OF PUBLIC HEALTH, N.S.W.

Coast Hospital.

Plague. **Case No.**

Diagnosis Clinical form Type (¹)

Name age, sex condition

Residence

Employment, place of

Nature of

Last attendance at

Admitted on 19 at m., Ward

D (²) on 19 at m., Total illness days

Previous History

History of Present Illness. Began on 19 at m.

Onset (³), First noticed

After that (⁴)

Bubo of region, first noticed on

as

Relation to previous cases

Relation to infected articles

Relation to dead and sick rats

Relation to fleas

Movements for 10 days previous to attack

Previous attacks at on

Inoculation at on 19

¹ Severe, moderate, mild.

² Discharged or died.

³ Sudden or gradual.

⁴ Onset symptoms, headache, vertigo, malaise, nausea, vomiting, weariness, aching, pain, rigor, prostration, hebetude, delirium, coma.

State on Admission.

On admission. T P R

General Condition—
  Prostration.
  Position in bed.
  Aspect.
  Expression.
  Pallor, flush.
  Eyes.
Nervous System—
  Apathy.
  Hebetude.
  Coma.
  Sleep.
  Restlessness.
  Delirium.
  Speech.
Circulatory System—
  Heart.
  Pulse.
Respiratory System—
  Lungs.
  Cough.
  Expectoration.
Alimentary System—
  Thirst.
  Appetite.
  Tongue.
  Vomiting.
  Bowels.
Urinary System—
Cutaneous System
  Skin generally.
  Rashes.
Bubo—
  Site.
  Size.
  Tenderness.
  Consistence.
  Colour.
  Pain.
  Periadenitis.
  Cutaneous lesions within drainage area of primary bubo.

SUBSEQUENT PROGRESS. (See also T Chart and Bed Card.)

Microbiological Laboratory. Forms of Record.

No. 3.

EXAMINATION OF RATS.

Consecutive No.	Date.	Source.	Species.	Condition.	Result.	Remarks.

No. 4.

DIAGNOSTIC EXAMINATIONS FOR PLAGUE.

No.	Date.	Patient's Name.	Residence.	Place of Employment.	Specimen.	Submitted by	Result of Examination.			Diagnosis.	Remarks.
							Smears.	Cultures.	Inoculation.		

No. 5.

MICROBIOLOGIST'S REPORT FORM.

Microbiological Laboratory, , 190 .

Plague, 1906.

Sir,

I have the honor to report the following result of my examination of

Submitted by

and received at this Laboratory for examination on

Result of examination.

Smear preparations :—

Culture :—

Inoculation :—

I have the honor to be,
Sir,
Your obedient servant,

Principal Assistant Medical Officer of the Government.

The Chief Medical Officer.

No. 6. Form No. 318.

DEPARTMENT OF PUBLIC HEALTH, N.S.W

[1] To be filled in by Secretary.

Plague Sanitary Inspector's Report. **Case** (1)

Name of Patient

Residence at

[2] Cottage, villa.
[3] Number.
[4] No. of rooms, attic, basement.
[5] Detached, terrace, &c.

Kind of house (2) of (3) storey rooms (4)

Situation (5) built of in repair

Cleanliness lighting ventilation

If connected with sewers

Outhouses

Trade carried on

Sanitary state

[6] Present, past

Signs of (6) rat infestation, consisting of

Vicinity, previous cases

Dead rats at

Plague rats at

Stables

Disinfection begun at a.m. p.m. 190 ; finished at a.m. p.m 190

Rooms disinfected (4) , viz. :

Clothing, &c., (as per attached list) removed for disinfection at a.m. p.m. 190

" " " returned to owner at a.m. p.m. 190

Further Data—

Names of Workmen.	

Sanitary Inspector
Supervising Disinfection.

APPENDIX B.

APPENDIX B.

Address on the Epidemiology of Plague.* By J. Ashburton Thompson, M.D., D.P.H., Honorary Fellow of the Incorporated Society of Medical Officers of Health, Honorary Member and Fellow of the Royal Sanitary Institute, Corresponding Member of the Epidemiological Society of London; Permanent Head of the Department of Public Health, Government of New South Wales.

I acknowledge gratefully the privilege conferred by the Executive of the American Medical Association in extending to me its courteous invitation to deliver an address on plague; and I have accepted it with the less hesitation that at Sydney we have had the good fortune to watch successive epidemics under conditions so favourable to complete observation, that probably we may have been enabled to see some things clearly which elsewhere have remained obscure. On behalf of the medical profession in New South Wales who have taken their part in the work, and whom, on this occasion, I poorly represent before you, as well as on behalf of my accomplished colleagues of the medical staff of Government, I thank you, and for myself bespeak your indulgence.

I. Introduction.

1. *Discordant views on the ætiology of plague and their causes.*

It is now twelve years since it first became possible to study plague by modern methods, and yet no conclusion on its ætiology has been reached which has met with general acceptance. Two causes, as it seems to me, have chiefly contributed to this disappointment. One consists in the appeal which has been persistently made to bacteriology for lights which, in fact, are not in its power to shed; the other in neglect of the epidemiological method, or at least failure to apply it effectively. In consequence, a field has been occupied by the bacteriologist which could not be profitably laboured by him alone. The epidemiologist has not seriously disputed this usurpation of his domain, and for his apparent apathy he has not been without excuses of some weight.

2. *Limitation of previous epidemiological investigation into plague.*

Plague has almost always prevailed in countries inhabited by races foreign to the observer in their language and modes of thought, who were of little instruction, of an education limited to ancient and immutable conventions, and who lived for the most part under conditions which unavoidably obscured the phenomena. It has thus often been impossible to acquire that exact and complete knowledge of all the circumstances under which the infection had been received by each person attacked, which is the foundation of investigations into the ætiology of disease by the epidemiological method.

The conditions adverted to notoriously existed at Hongkong and in India; they made themselves more or less completely felt in New Caledonia, in Madagascar, in Mauritius, in Egypt, and in parts at least of South America; and they obtained effectively in South Africa where, although the ruling population is English, the burden of disease fell on the natives and on immigrants from the East. But plague has visited some places where the conditions were more favourable to investigation, and from them (as well as from those just mentioned by name) much information of clinical, pathological, and administrative value has been forthcoming; but there the principles and uses of the epidemiological method seem to have been greatly overlooked.

3. *Relative absence of such limitation at Sydney.*

At Sydney the conditions happened to be much more favourable to its employment. The invaded population numbered about 500,000. It was not merely wholly white, of English extraction and speech, and fully civilised, but intelligent, instructed, and orderly, accustomed to direction and amenable to it. Management of the outbreaks rested solely with the central Department of Public Health, which had not merely wide statutory powers, but in unforeseen contingencies had the practically unlimited authority which the Executive Government occasionally conferred upon it. It enjoyed a measure of absolute power, therefore; and I need not tell those who have in mind the brilliant sanitary campaigns of Havana, Manila, the Isthmus, and New Orleans, that our knowledge can be used to full advantage of gravely afflicted communities only when some such power is entrusted to the supreme health authority.

4. *The subject of investigation.*

I have not drawn attention to these circumstances unnecessarily. They constitute the condition precedent to success in any epidemiological investigation to which, as is the case with plague, co-operation of the people themselves is requisite. So advantageous were they indeed, that I am tempted to refer to our observations as "normal observations," and to our results as "normal results." The subject of inquiry, it is well to add, was not plague in general, but epidemic plague in the two clinical forms which at present are distinguished as the bubonic and the septicæmic. From them the third clinical form, known as primary plague pneumonia, differs so remarkably in its mode of spread, which is simply by direct communication from the sick, and is so much less commonly encountered that it may be left aside.

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* Read before the Congress of the American Medical Association, Boston, 1906.

5. *Conclusions on the ætiology of plague reached at Sydney.*

With the great mass of data which the epidemiological method placed at command, and which has been fully set forth in a series of published official reports, I have framed the following conclusions by induction :—

(*a*) Plague owes nothing of its epidemic form to communication with the sick ;
(*b*) Plague in the rat is a necessary factor in epidemic plague ;
(*c*) A living intermediary is necessary to communicate the infection from rat to man ;
(*d*) That intermediary must be the flea in one or more of its many species.

II. PHENOMENA OF EPIDEMIC PLAGUE.

1. *The infection is not diffused by communication with the sick.*

(*a*) *Direct communication.*—In 1900, when plague first made its appearance in this quarter of the world, and at Sydney, the disease was generally thought to be maintained and diffused by communication with the sick.

In "The Bombay Plague : Compiled under the Orders of Government by Captain J. K. Condon, Indian Staff Corps. Bombay, 1900," ignorance of the origin and modes of spread of plague was deplored (p. 12). While escape of persons employed in hospitals was taken to show "that the germs produced in the bodies of the sick were but little infectious to healthy persons under ordinary circumstances" (p. 72), it was, on the other hand, stated that "the microbe is capable of thriving and multiplying outside the animal body . . . ," so that "the germs may be conveyed by persons who are themselves insusceptible to plague, and having grown and multiplied on suitable media . . . may infect large numbers of people . . . " (p. 69). And the general trend of Hankin's observations was said to indicate that the chief source of infection would more probably be found in "the recently passed excreta of men and of animals suffering from the disease" than in a saprophytic growth in the soil (p. 111). At the date mentioned exact evidence on the communicability of plague was not possessed.

At the present date official opinion in India is that communication with the sick is a means of maintenance of the disease, and must be borne in mind in framing preventive measures. In a resolution of the Government of India, dated Calcutta, 17th January, 1906, designed to place on record in concise form the results of practical experience acquired in the management of plague during the preceding five years for guidance of Presidency and Local Governments, the following sentences were included :— " . . . the inspection of travellers by railways, road, and steamships is often successful in averting or delaying the spread of plague . . . " (par. 6) ; "The example of prisons proves that quarantine may be relied upon to prevent the spread of plague by human beings . . . " (par. 7). "The removal of the sick to hospital . . . is instrumental, however, in delaying the spread of the disease . . . " (par. 8).

That outbreak consisted in 303 cases, and the requisite particulars were learned in 289 of them. Those 289 persons had lived in 276 dwellings ; 266 of the dwellings had harboured but a single case apiece. After an interval of fifteen months, during which no plague had been seen either in man or in animals, the second outbreak began. It consisted in 139 cases, which were found in 124 dwellings (including one ship 'ong in port) ; 115 of those dwellings harboured but a single case apiece. Subsequent experience has been precisely the same. The patients were very promptly removed to hospital after notification, no doubt, but in the vast majority of cases which came under treatment notification was delayed until the third day of illness, or later still ; additional to them were fifty-one persons who died at home at, or before, the hour of notification. All these persons, then, had ample opportunity of communicating their disease to their house-mates, but, as appears from almost all the dwellings having harboured only one case, they did not do so. Further, many of these persons received the infection at the centre of the city which was the original point of invasion, and retired to their dwellings as soon as they began to feel ill. Those dwellings were situated in large proportion in the suburbs, from 2 to 3 miles up to about 10 miles away from the centre ; and about a dozen persons reached places some hundreds of miles away where they passed through their illness under circumstances which did not permit of isolation from the rest of the family, nor, perhaps, from their neighbours. In all of the very distant places, and in a very large proportion of the suburban places, no plague either in man or in animals was afterwards seen. Non-communication was the rule, then. Secondary cases did occur occasionally ; but I shall show that they resulted from exposure to a common source of infection, not from communication with the sick.

Even in India it has turned out to be possible to examine the question of communicability in a similar way ; and as soon as it was so examined similar evidence was obtained. In his report on plague in Calcutta, for the year ending 30th June, 1904, Dr. T. Frederick Pearse, Officiating Special Health

Officer, stated the figures for three of the districts of the city. In District I, 1,521 cases occurred; 1,002 huts furnished only 1,173 cases, and 287 pucka buildings only 316 cases (and 32 cases were undistributed). In District II, there were 2,049 cases; 1,023 huts furnished only 1,222 cases, and 642 other buildings 827 cases. In District III, there were 728 cases; 539 huts yielded but 582 cases, and 127 pucka buildings only 137 cases (and 9 cases were undistributed). Unfortunately notification was far from complete, though improved; however, Dr. Pearse thought that this evidence weighed against maintenance by communication with the sick, against indirect communication by fomites, and against persistence of the infection on premises.

(*b*) *Indirect communication.*—Dissemination of the infection by means of articles which had become infected in plague-houses so as to contribute importantly to production of an epidemic, if at all possible, could take place only if those who suffered commonly pawned or sold their household goods during illness. As a matter of fact, no such diffusion of articles took place. Distress, consequent on illness and loss of work, had not time to make itself felt before the houses fell into the hands of the disinfecting staff. But were the infection commonly capable of being spread indirectly by infected articles, no such clear answer as that given to the preceding question could have been made. We have no ground for suspecting that the infection of plague can be spread by clothing, bedding, or other articles of household use.

Can articles which were not infective within houses become so as a consequence of mere removal outside the houses? Accounts are forthcoming from India of transmission of this infection with clothes, or by persons who were not themselves suffering. The surrounding circumstances in which such cases were observed have not been described in the requisite detail; however, had sufficient experimental evidence that fleas could communicate plague been already adduced, then it would be easy to understand how articles which appeared to be not infective within houses might become so after issuing from them. For during transport the fleas would be starved, and they would seize the first opportunity of taking blood (Tidswell—Report, Sydney, 1902, p. 73; Gauthier et Raybaud, "Revue d'Hygiène," XXV, p. 426, May, 1903). It should be noted with reference to those Indian accounts that our people, having been respectable artisans for the most part, were not infested with vermin as the poorer natives of India generally are.

The evidence, then, collected under the usual conditions of civilised life in 1900, and in 1902, suffices to show that neither direct nor indirect communication with the sick is a factor in causation of epidemics. This fundamentally important judgment has been fortified by all the experience of subsequent years. It carries with it the corollary that *the infection spread in epidemic form by means which were* (*a*) *external to man, and* (*b*) *independent of his agency.*

2. *The infection is associated in some way with locality.*

The disease claimed many victims, although it did not spread from person to person. The infected must have shared something, therefore. We discovered what this was as soon as scrutiny of dwellings in relation to infection was exchanged for scrutiny of work-places. Already, in 1900, seventeen groups of cases had been noted which consisted of from two to four persons in each, the total number concerned having been forty-three persons, who occupied forty-three separate and scattered dwellings. There was no other bond between the components of each of these groups than resort to the same work-place. In subsequent years we met with other groups of which the component persons were connected solely by resort to the same work-place, the same hotel, or (in one case) even to the same theatre. Under our "normal conditions," we were able to establish the important facts concerning each of them fully, and quite certainly.

3. *Incidence of the disease on households is erratic.*

Yet infectiveness of the locality did not insure the infection of persons present in it. On the one hand non-communication of the disease from the sick prepared us to meet with but single cases in dwellings, and that was the rule; on the other hand connection of the infection with locality seemed to make it almost certain that secondary cases must be met with in buildings which were places of infection for primary cases. Accordingly, secondary cases often occurred in buildings which were infective; nevertheless much the most commonly only one person suffered out of several who were equally exposed, and who (since man's natural resistance to plague is very slight) were all equally susceptible. I wish here to direct attention more especially to the very commonly observed escape of all but one member of the exposed group. It has from the beginning caused me to suppose that a chain of circumstances which is rarely complete in all its links must be necessary to the infection of man—(Report, 1900, p. 36).

4. *Extension of local infection by contiguity.*

The infection always first made its appearance at some one spot; never at more than one. From that spot it extended continuously, and its progress could be watched. The limits of the area on which it was present could be and were ascertained, time after time; and although in the nature of the case they could not be sharply defined, it was always possible to say where plague-free areas existed beyond them. This way of spreading I distinguish as "extension by contiguity."

5,

5. *Extension of local infection per saltum.*

While the infection was manifest only at the point of primary invasion, it often made appearance quite suddenly at some distant point, and there created a new focus. The intervening country although covered with houses remained unaffected either permanently, or until some very much later date when it became infected by contiguity, either from the central focus or from the secondary focus itself. It appeared that the infection could be transported safely, be planted afar, and could there take effect. In that there is nothing novel, for the same happens with several communicable diseases. It becomes remarkable and important when it is remembered that, in accordance with our fundamental observation, the infection of plague is not maintained or diffused by communication with the sick. This way of spreading I distinguish as "extension *per saltum*."

6. *Incidence of the infection on houses is erratic.*

From the beginning it was observed, as well in urban as in suburban districts, that infection of a house betokened no particular danger to the adjoining houses. But it did betoken danger to houses in its neighbourhood. It was remarkable that the apparently imminent danger was realised but rarely, while the apparently remoter danger was almost invariably realised sooner or later.

7. *Sub-epidemics.*

For convenience of description outbreaks which result from extension *per saltum* may be called "sub epidemics." In reality they have their own independent status, and are as much entitled to be named "epidemics" as is the outbreak at the point of primary invasion. The sole difference between the primary and such secondary outbreaks is this: Whereas the infection was carried from great distances oversea to the point of primary invasion, it was carried from that point to the secondary foci over the shorter distances which separated them from it. The numerous secondary outbreaks which we have witnessed were not the less independent that they were isolated by but a mile-wide ring of plague-free houses, nor the more independent that they occurred (as we have seen) 70 miles or 300 miles away from the point of primary invasion; nor were those distant sub-epidemics less independent than was that at the point of primary invasion itself, though the latter may have stood thousands of miles from the source of its infection. A consequence of great value in the epidemiological investigation of plague flows from this. It is that sub-epidemics can be compared with the primary epidemic, and with each other. Even in a single city checks on observed data thus become available; corroboration, also, on points which stand the test of such comparison. It will appear presently, I believe, that the mode of diffusion of plague is always one and the same, and that distance is an incidental accompaniment, without real significance, and of very little practical importance.

8. *Infected areas.*

It is customary to speak of "infected areas," and the phrase is convenient for administrative use. But in epidemiological terminology it is inexact. Our "normal results" have shown that the infection of man is almost always contingent on his presence within buildings of some sort. Infectiveness of areas is entirely conditioned by the infectiveness of some of the buildings which stand upon them.

9. *Non-persistence of the infection in localities.*

The infection is but casually connected with localities; it does not inhere in them.

(*a*) *Districts.*—The after-history of a good many areas on which sub-epidemics have occurred, raced during terms of years from six downwards, has shown that the most ordinary processes of scavenging and cleansing as applied to accumulations of rubbish, dilapidated buildings, backyards, and basements, has sufficed to banish the infection. Any such area might of course become reinfected *per saltum* from any other distant area with which it remained in unguarded communication; but in the many instances I now have in mind this happens not to have occurred, with a single conspicuous exception. This consisted in the central area itself. One small part of our extensive wharf-lines has always been the point of primary invasion; it does not measure much more than a mile in length. I shall be able to show at the proper time, that this is one of those exceptions which prove the rule. Our "normal" observation is secure; simple scavenging of rubbish and filth without any general disinfection or other special method, gets rid of the infection once for all.

(*b*) *Houses.*—221 houses were adjudged in 1900 to have been the places at which many of the 303 cases of that outbreak had received their infection; they were infected houses, and the cases they yielded were "indigenous" to them. In 1902 the disease revisited the area on which those 221 infected houses stood; and then 86 houses were adjudged to have been places at which 113 persons received their infection. But in the second epidemic large areas which had carried places of infection in the first epidemic were entirely spared. No fewer than 215 of the 221 plague-houses of 1900, escaped in 1902; and as regards the six houses which were revisited in the latter year, only four of them could be regarded as having been places of infection in both years, the other two having merely harboured persons who were adjudged to have received the infection elsewhere. Since the infection recurred in the second outbreak on the same area, it was manifestly probable that a few houses would be invaded a second time; and that, I think, is the proper view to take of the very small residuum of four houses out of 221 which were places of infection in both years. This exact statement has been supported by the result of all further "normal" observation. As the infection does not inhere in localities, so neither does it inhere in buildings; but to both it may be reimported.

The suggestion that plague is an infection of locality has authority. The Chinese have always (as far as we know) held the opinion that plague emanated from the soil, and probably they deduced it from having observed that what they took to be the same disease as killed animals which live near to or in the soil afterwards attacked man. They elaborated it into the fantastic theory on which plague was thought by them to attack many kinds of animals in a succession regulated by the height at which they carry their heads above the ground, so that man suffered last. This belief, that the infection of plague resides in the soil, has been entertained and advocated by Creighton, who adopted it in his "History of Epidemics in Britain," and reaffirmed it in 1905, after having paid a visit of investigation to India. He thought the infection rose to the interior of dwellings with the ground-air, and was commonly taken by man with the breath. (Journal of the Society of Arts, LIII, pp. 813 and 824). The belief "that plague is essentially a disease of locality," and that houses are infective in themselves, is general in India (English Plague Commission in India, par. 221).

Our "normal" observations have furnished no support to this view. As it appears to me, the infection can only exist under the following forms—(*a*) as an infection of the animal body, be it vertebrate or invertebrate; (*b*) as a discharge from the animal body on inanimate objects, to which I have allocated the phrase "deposited infection"; and (*c*) as a saprophytic growth. But I have just given some reasons, and before concluding I shall adduce others, for thinking that it does not exist in efficient form (efficient, that is to say, *quâ* epidemic prevalences) outside the animal body.

10. *Outline of the epidemic form.*

The general form of our epidemics, and of all epidemics (except those of primary plague-pneumonia) concerning which the details are sufficiently known is—(*a*) commencement in a very few cases which are separated from each other by considerable intervals of time, (*b*) a more rapid succession of cases, and (*c*) a conclusion resembling the commencement but, as a rule, not so long drawn out. This outline is clearly seen when the number of cases is considerable, but it is lost when the number is small, and the character of the outbreak then seems to be mere irregularity of the order of succession; the intervals between the cases being often many times as long as the incubation period of the disease.

The latter point is conveniently illustrated by our fourth outbreak, which consisted in twelve cases only. I give the intervals after premising that the incubation period of plague is most commonly three days or less, and perhaps may be said never to exceed five days. The date of attack in the first case of 1904 was 9th of March; the successive intervals at which the remainder occurred were 32, 10, 12, 3, 13, 17, 6, 20, 41, 38, and 3 days (but the last two cases occurred in the same house).

11. *Epidemic plague is associated with epizootic plague.*

Our investigation of the twelve cases in which the small outbreak of 1904 consisted was pushed to the last extremity. It will be well worth while to examine the places of infection under their group-aspect at this point, for we are on the brink of an important transition. The number of infective premises was nine; seven of them, of which two furnished two cases each, were grouped by standing at or near the point of primary invasion; the eighth and ninth (which latter also furnished two cases) stood about 6 and about 10 miles away from it in opposite directions, and were infected from it *per saltum*. Now, we have learned already that the infectiveness of districts is conditioned by the infectiveness of particular houses which stand within them; and when the relationship of the seven premises which in the district-sense were grouped was examined more closely, it appeared that in reality they did not stand near each other, but in almost every case were rather widely separated—separated, that is to say, by two or three blocks, by a quarter of a mile of city property, or even by longer distances. Something they shared, for they were all infective; but that something can have had no essential or necessary connection with the area on which they stood. We found the circumstance which was common to all of them in the presence of plague-rats. That, and that alone, distinguished the district in which seven of them stood, and the two distant, separate, neighbourhoods in which the eighth and ninth stood, from the rest of the metropolitan area. I have mentioned these results in connection with 1904 partly because the small number of cases makes that outbreak a convenient example, and partly because in that year we established the distinction mentioned, namely, the presence of plague-rats in every case without exception; but it had also been observed by us in previous years.

* * * * * * * * * * *

If all the "normal results" which I have described separately be now considered together, I think it will be conceded that nothing can co-ordinate them, and reconcile the apparently contradictory features of some of them, except the assumption that *the infection of plague exists in, and is disseminated with, the bodies of some species of lower animal which is free to wander.* Thus the centre of interest passes for the present from man, to the only animal which at once lives in close association with him and is conspicuously subject to plague.

III. PHENOMENA OF EPIZOÖTIC PLAGUE.

1. *Need to watch the rat closely and continuously.*

The association between plague in man and in rat which has now been very frequently observed in many different parts of the world tempts the inference that man takes plague from the rat; and it has been very generally drawn. However, on reflection it will appear that no good ground of inference has thus been disclosed, and that in reality only a coincidence has been noted which collateral circumstances have shown to be worth investigation—the scent, not the quarry. But systematic investigation has rarely been accorded to it. As a rule the observed points consist solely in (*a*) plague in man, and (*b*) concurrent plague in the rats in his neighbourhood. Nothing is known, or at least nothing has been intelligibly recorded, of the rats over the whole of any town, in the parts where plague is not as well as those in which it is. Hence the question of causality has been left open. A suggestion that both may have taken the infection from some common source remains plausible; and it is by no means disposed of by showing (as has been shown with that intention) that persons who live away from the rat-infested neighbourhood only take the disease if they resort to it, or only after diseased rats have been observed in the neighbourhood of their dwellings. In order to elucidate it, it is necessary that the rat should be watched all the year round, while plague is present and when it is absent; and in reporting results it is further necessary that the duration, extent, and means of search, as well as the way in which infection with plague was ascertained, should be carefully described. This has not yet been done in India; and it is precisely in India that many experiences have been recorded from which, it is said, it has been learned that epidemic plague can occur out of association with rat-plague. I am going to show that although plague rats do in India and in some other countries often come out to die in the open, and thus to some extent offer themselves for inspection, systematic detection of rat-plague is in reality a difficult business.

The methods employed at Sydney fell under two heads; rat destruction and rat intelligence. *Rat destruction* was secured by payment of a capitation fee for carcases to the public; the carcases were delivered at furnaces where they were recorded and burnt. The furnaces were in charge of intelligent men of the temporary staff, who were directed to report any general information they might pick up. None of the rats received there were examined in the laboratories, because good information as to the places at which they had been taken could not be got from the persons who usually delivered them. *Rat intelligence* was got through a special staff, which consisted at first of the best men we could find; but by a careful process of weeding out a trustworthy corps was gradually got together, most of whom at the present date have been continuously employed since the beginning of the second outbreak, 1901–2. The provenance of all rats taken by this staff was accurately known. The catch of the previous night was delivered at the laboratories with the address at which each animal had been taken attached to its carcase; the address was entered in the rat register; the carcases with their attached addresses were handed to the staff of laboratory assistants, and were examined by them under supervision of the Director. The results were then entered in the register. As soon as plague was detected in a carcase which came from a house not previously known to carry the infection, the address was communicated to the medical staff, and was spotted on a map; the sanitary staff was instructed to repair to the premises with their scavengers and cleansers; their operations began with the infected premises and the adjoining premises on each side of them, but were extended to the whole block. Every rat taken during these cleansing operations, as well as the particular premises in the block on which it had been found, was also examined and was recorded. The general sanitary state of the block was reported in detail by the Sanitary Inspectors (all of whom were trained and certificated); they drew attention to matters of special importance, and these were further examined by a Staff Medical Officer. This method has been followed continuously since 1st April, 1902, and is effective at this moment. In plague-free times there has been no need for it in some of its details; but examination of rats by means of the intelligence staff has never been intermitted. Their work has not covered the whole of the 256 square miles of the metropolitan area, any more than it has extended to the whole of the 311,000 square miles which the State comprises. Experience has taught us that when the infection reappears it will be first found at the short length of wharf line already mentioned; and to a wharf line of about 4 miles in length which includes that portion, and to the immediately adjacent streets of the city, the unremitting work of the intelligence staff has been confined in times of peace. Every item of information has thus been systematically recorded; and nothing concerning plague among the rats of Sydney which can be learned in such ways, neither as to its presence nor as to its absence, remains hidden from us. But I would not draw an exaggerated picture. We had to learn this business ourselves, and we had to teach the public, without whose intelligent help much of what we know must have remained undiscovered; and therefore, although the above statement is quite correct, it should be noted that we improved both in accuracy and completeness as experience accumulated, and our teaching spread.

The Director of the Laboratories was Dr. Frank Tidswell. I shall often have occasion to refer to his special work, when time permits; it sufficiently testifies his industry, skill, learning, and judgment, I believe, to those who have made acquaintance with it in the series of reports on this subject which has been published.

Invariably I use the word "identified" in relation to plague, to indicate discrimination of the disease by morphological, cultural, and inoculation methods, comparatively applied in all their respective details. Suspected plague, whether in man or in animals, was thus rigidly investigated whenever circumstances rendered certainty desirable (in first cases, for instance; in all other animals than the rat—marsupials, whose susceptibility to this infection was first noted by Tidswell; in "naturally-infected" guinea-pigs, because at our date of observation this event had been but once before recorded, and in a summary fashion; in all cats, dogs, &c.; and in all cases met with or suspected on board ship).

2. *Species of Rats.*

It is convenient to speak of the rat in general, but I wish to be understood to comprehend under that word three species and a variety. These are *M. decumanus*, the grey rat; *M. rattus*, the black rat, with its variety, *M. Alexandrinus rufus*; and *M. musculus*, the grey mouse. We meet with all of them; all suffer from plague in nature in epizoötic form; and we have found all of them associated with plague in man.

M. decumanus is the grey rat; it lives in burrows, infests sewers, basements, and rights-of-way, and feeds on garbage. It can by itself cause plague in man, as we saw in the case of the troopship "Antillean" which carried no other species, and on which two cases of plague occurred in port, but before pratique had been granted (Report, 1902, pars. 50–64). We have also found this species far from any town on the banks of a river 300 miles north of Sydney, where, no doubt, specimens had been originally landed from Sydney cargo boats. At the time of examination they extended to premises inland, where they were found in the village and on farms; there, also, they alone were the cause of 12 cases of plague, of which 7 were fatal, and which occurred in 10 houses. Large numbers of rats were examined; there were but half-a-dozen *M. rattus* among them, all of which were plague free, while all the infected rats, of which there were many, were *M. decumanus* (Report, Sydney, 1905). This species cannot be tamed, and in captivity soon dies, as a rule.

M. rattus is the black, or ship rat; together with its variety, *M. Alexandrinus*, it prefers upper floors, roofs, sometimes the branches of climbing plants, and feeds on grain and fruits. This species is easily tamed, and lives, but will not breed, in captivity. We have found *M. rattus* alone in connection with plague in man; we have also found it in the same connection in conjunction with infected *M. musculus* only, and apart from *M. decumanus*. It, too, can by itself cause plague in man.

The opinion formed from our four years' continuous examination of rats is that at Sydney they breed all the year round, but probably a little less freely in the four colder months. At Brisbane, Queensland, which lies about six degrees further north, it is thought that they breed all the year round without variation.

Mice are less susceptible to experimental plague than are rats; from the following I infer that they may also be less susceptible in nature. During the epizoötic period, 1st March to 3rd December, 1904, 20,394 rats were examined, and ·9 per cent. were infected; by the same men during the same term 23,428 mice were collected on the same area, of which ·26 were infected. However, it must be remembered that these figures express only what happened to be found, and are incomplete. All the rats were not caught; still less were all the carcases discovered.

Rats eat each other in nature; rather more than 8 per cent. of the carcases brought in have been partly devoured, but sometimes so completely that nothing but the head, paws, tail, and skin remained. We have also ascertained that rats eat mice in nature.

3. *Small proportion borne by infected rats identified to total rats examined.*

I take for convenience the 2¾ years which ended on 31st December, 1904. During that term 125,872 rats and mice were examined in the laboratories. Out of this total (which included none of those brought in by the public) plague was identified in but ·37 per cent. On the other hand, the meaning I attach to the word "identified" (see above) must be borne in mind. A large number of putrid carcases came to sight, in which, no doubt, plague had been the cause of death, though it could not be bacteriologically identified; yet if these could be reckoned as well the discovered deaths from plague would still compose but a small percentage of the total taken. Very many plague rats die in their holes, where we have found some of them; the majority remain undiscovered.

4. *Sick rats not often seen in the open.*

With us, the occasions on which sick rats have been reported to have come into the open could be counted on the fingers; they do not commonly discover themselves in the way so often seen in many countries. On the other hand they do die in unusual places, and so regularly that we feel justified in regarding the discovery of three or four carcases at a similar stage of decomposition, under floors, or in, or on the tops of cupboards, &c., during known presence of an epizoötic, as probable evidence of death from plague. In ordinary, as is very well known, rats generally die out of sight: nuisance from them is uncommon. The contrary is the case when plague is epizoötic. Even when poison has been laid, discovery of several dead bodies in such situations should arouse suspicion.

5. *Difficulties of rat-catching.*

Rats have to be searched out therefore; and to illustrate the difficulty of finding them I cannot do better than repeat the following statement:—During a term of eight months, the Intelligence Staff paid 17,656 visits to foreshores, wharves, and stores; only 4,095 of those visits resulted in captures, and the number of rodents taken was only 10,579. These premises were entirely open to the men; but had the area examined been residential it is clear the result would have been still less satisfactory, since admission at night would often have been refused to them.

6. *Healthy rats most often caught.*

The means of catching necessarily selected, namely trapping, is obviously more likely to lead to the taking of healthy rats, active in their search for food, than sick rats, as I pointed out in 1902.

7. *Irregular Infestation of Buildings.*

We have found that all the buildings which seem to be likely to harbour rats are not infested with them. House-to-house examination of a group of blocks of squalid, but solidly constructed, buildings, which contained 387 houses, resulted in finding fifty-seven infested with rats, or about 15 per cent only; although all of them from dilapidation, and a majority from the uses to which they were put, appeared equally exposed to infestation. These blocks, then, furnished an explanation of the erratic incidence of plague on houses which has already been mentioned—not in that these fifty-seven were infected, but, in that they alone were infested.

8. *Small number of Plague Rats usually found on Single Premises.*

The number of plague rats found on premises is usually small—that is to say, from three or four, to half a dozen; but occasionally, and for no obvious reason, the number has been large. I can mention 69, 154 dead and 35 living, 72, 39 dead and 3 living, 80, 45, &c., found, for the most part, at produce stores under the floor of shops which had no basement; but these were quite exceptional numbers.

9. *Slow progress of the Disease in Hordes.*

With those few exceptions, also, the progress of the disease among the horde infesting any premises has been usually quite slow. This is an observation of so much importance that in 1903 I published nine tables in illustration of it. Plague rats and plague mice were taken over quite long periods in conjunction with healthy rats and mice; and notwithstanding disturbance the healthy animals continued to be caught long after the last infected animal had been taken. So that although for some unknown reason plague occasionally sweeps off the whole horde, it very much more often follows a slow course in buildings—as it did also on the troop-ship "Antillean," which was infected at Cape Town, but arrived at Sydney twenty-nine days later with some plague rats and many more healthy rats on board her; and when it does so, the horde does not become alarmed, and does not flee the premises.

Examples of slow progress of Plague among Hordes of Rats.

BADLY-KEPT Stabling for 100 horses, which stood on about 1,500 square yards of blown sand, a long distance from the point of invasion.

Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 June ...	12	......	11	......
16 „ ...	30	2	18	......
17 „ ...	17	9	10	......
18 „ ...	20	6	11	1
19 „ ...	30	3	13	......
20 „ ...	18	7	......	......
22 „ ...	7	......	1	......
23 „ ...	6	8	......	2
24 „ ...	4	5	......	......
25 „ ...	1	3	......	1
26 „ ...	......	3	......	1
27 „ ...	2	1	......	1
29 „ ...	1	6	......	......
30 „ ...	2	1	......	1
1 July ...	......	6	......	1
3 „ ...	......	2	......	......
4 „ ...	......	2	......	......
6 „ ...	......	2	......	......
7 „ ...	......	1	......	......
8 „ ...	......	1	......	......
9 „ ...	......	2	......	......
10 „ ...	......	1	......	......
13 „ ...	......	1	......	......
14 „ ...	......	1	......	......
1903.				
15 July ...	......	3	......	......
16 „ ...	......	2	......	1
18 „ ...	......	2	......	......
20 „ ...	......	2	......	1
21 „ ...	......	2	......	......
22 „ ...	......	1	......	......
24 „ ...	......	2	......	......
30 „ ...	2	......	......	......
7 August ...	1	1	......	......
10 „ ...	......	2	......	......
11 „ ...	1	2	......	......
12 „ ...	1	1	......	......
13 „ ...	......	2	......	......
14 „ ...	......	2	......	......
15 „ ...	1	1	......	......
17 „ ...	1	......	......	......
18 „ ...	1	......	......	......
22 „ ...	......	1	......	......
24 „ ...	1	......	......	......
26 „ ...	2	1	......	......
27 „ ...	2	......	......	......
28 „ ...	1	1	......	......
31 „ ...	2	......	......	......

PRODUCE Stores at the point of Invasion.

A.				
Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
21 May ...	1	2	......	......
21 " ...	......	1	......	1
22 " ...	1 cat	1	1 cat	1
22 " ...	1	......	......	......
23 " ...	1	4	......	1
25 " ...	......	3	......	2
26 " ...	1	4	......	1
26 " ...	......	4	......	1
27 " ...	......	3	......	2
27 " ...	......	8	......	......
28 " ...	......	4	......	1
29 " ...	......	7	......	2
30 " ...	......	16	......	......
1 June ...	......	8	......	......
1 " ...	......	4	......	1
22 " ...	......	2	......	......

B.				
Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
16 May ...	2	......	......	......
19 " ...	2	1	......	......
22 " ...	2	......	......	......
23 " ...	1	5	......	......
12 June ...	......	3	......	......
6 July ...	1	1	......	1
7 " ...	1	2	......	2
8 " ...	1	18	......	......
9 " ...	......	2	......	......

C.				
Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
18 May ...	8	4	......	......
19 " ...	2	1	1	......
18 June ...	......	7	......	......
19 " ...	......	4	......	......
20 " ...	1	4	......	......
22 " ...	2	2	......	......
23 " ...	......	3	......	......
24 " ...	......	5	......	......
25 " ...	......	3	......	......
26 " ...	......	2	......	......
27 " ...	......	1	......	......
29 " ...	1	......	......	......
30 " ...	......	1	......	......
1 July ...	2	1	......	......
2 " ...	1	......	......	......
4 " ...	4	3	......	......
6 " ...	......	1	......	1
7 " ...	......	1	......	1
9 " ...	3	10	1	5
10 " ...	......	4	......	......
13 " ...	......	1	......	......
17 August ...	......	2	......	......
18 " ...	......	1	......	......
19 " ...	......	1	......	......
21 " ...	......	1	......	......
22 " ...	2	1	......	......
24 " ...	......	1	......	......
25 " ...	......	1	......	......

D.				
Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 May ...	10	5	......	......
18 " ...	47	47	......	......
19 " ...	1	1	......	......
20 " ...	9	......	......	......
25 " ...	......	1	......	......
26 " ...	1	......	......	......
27 " ...	1	......	......	......
5 June ...	3	1	......	......
6 " ...	3	1	......	......
9 " ...	2	......	......	......
10 " ...	1	1	1	......
11 " ...	1	......	......	......
15 " ...	16	7	3	......
16 " ...	8	5	7	......
17 " ...	12	5	......	......
18 " ...	5	3	2	......
25 " ...	......	2	......	1
29 " ...	1	......	......	......
1 July ...	1	......	......	......
25 " ...	......	7	......	......

10. *Limit of the functions of the rat-search.*

These observations explain at once the long continuance of epizoötics, the small percentage of rats in which plague has been identified, the larger but still small percentage of rats reasonably presumed to have been killed by plague, the slow spread of the disease among the rats, and the small number of separate premises at which presence of the disease in rats was established. Two practical conclusions to be drawn from

rom them are these: First, a properly organised search can be made to reveal the limits of the area over which the epizoötic extends, but our best efforts will never tell us what the severity of the epizoötic was; secondly, discovery of a single plague-rat should be taken as the signal for strenuous exertion by the sanitary authority in that neighbourhood, and even in that quarter of the town. The percentages given above, it will be noticed, indicate merely what we succeeded in finding, not all that happened.

11. *The interval between epizoötics, and the "bridge" which connects them.*

The intervals between our epizoötics were in order, fifteen months, eight and a half months, six and a half months, and forty-five days. Two causes have been assigned to recurrence and to persistence of rat-plague. One is possible saprophytic persistence of the bacillus, external that is to say, to the animal body; of that suggestion I believe I have disposed as far as Sydney is concerned by showing how easily areas are permanently rid of their infection. The other is that the rat is affected with plague in a chronic form, which causes but few deaths until something occurs to revive its virulence. I do not deny existence of a chronic form; but I say that while on the one hand we have failed to obtain any evidence which points to it, on the other hand we have found it an unnecessary hypothesis. Why had we intervals so widely different as one of fifteen months and one of forty-five days? As regards the former the obvious explanation of its length is that the disease had in reality been extinguished.

This, though unusual, is not unique; Cape Town furnishes a remarkable example of it. The first identified case occurred in February, 1901, the last 2nd January, 1902; altogether 766 were recorded. The first identified plague-rat was taken on 4th February, 1901, the last 19th January, 1902. No further plague case has since been recorded and, notwithstanding steady watch, no further plague-rat (but there was an outbreak of rat-plague at Lady Grey Bridge, a suburban railway-station outside Cape Town in November, 1903, of which no explanation has been published). Cape of Good Hope; annual reports of the Medical Officer of Health for the Colony, 1903. Oporto yields another instance.

As regards the latter we may say without presumption that we know it was cut short by reimportation from another part of our own State. At all events while we had probably infected a northern river district (where an epizoötic began about the middle of December, 1904) by means of the numerous steamers which carry on the produce and dairying trades with it, the first plague-rats in 1905 at Sydney were caught at the very wharf at which those steamers lay to discharge. Secondly, as to the other two intervals of eight and a half and of six and a half months; during them we can say (if our continuous and careful search throughout them availed anything) that we were certainly free from plague in rats; none of the 17,160 taken by the Intelligence Staff during the first, and of the 18,456 taken by it during the second, had plague. Thirdly, from the 18th of January, 1905, to this date, plague-rats have been found continuously; in very small number, and on the very short line of wharves already referred to, it is true, but they were all rats which had died of acute plague. These being the observed and, we believe, the completely observed facts, it seems to me that reference to chronic plague becomes superfluous; and as very little indeed has been ascertained regarding it, further reference to it may be deferred.

Such experience, again, is not exceptional. In accordance with what I said above, namely, that the need to watch rats as carefully as man had been generally overlooked, hardly any precise evidence on this point is forthcoming from other parts of the world. However, much the same thing seems to have been recently observed in Calcutta by Dr. Frederick Pearse (ubi cit sup.); and from returns regularly published by Dr. John A. Gregory, Medical Officer of Health for Cape Colony, it appears that plague-rats in quite considerable number have been taken at Port Elizabeth in almost every week from 23rd August, 1902 (at all events), to January, 1906. As far as I have been able to make out, the same may have happened at Hongkong; but as no one knows, nor ever has known, whether the plague-rats recorded there belonged to Hongkong, or were imported for the sake of reward from neighbouring villages or the mainland, much stress cannot be laid on that (see Report of the Acting M.O.H. on Plague during the first seven months of 1903, p. 6, by Dr. Wilfrid W. Pearse).

12. *Where plague-rats are most constantly found.*

Analysis shows that plague-rats have been found most persistently at wharves, then in warehouses and shops, then in stables, and then in more or less dilapidated cottages. One circumstance is common to all these kinds of places; either they are easily accessible to rats (*Cf.* Hankin on plague at Bombay, Annales de l'Institut Pasteur, XII), or are used in ways likely to attract rats. Such uses are the storage and distribution of food-stuffs. But there is one use which is pre-eminently favourable to rat-infestation, and in connection with which we have most commonly found plague-rats; this is the produce trade in hay, straw, chaff in bags, maize, and potatoes. This point is well and importantly illustrated by our wharf experience. I do not know what the total length of the wharf-line at which sea-going vessels lie may be, but it is many miles. Now I have already said that our continuous examination of rats has been confined in time of peace to a wharf-line which measures only about 4 miles, and that we have learned that when plague recurs it will first show itself at a part of that line which is a little more than one mile long. But we can be a little more exact, and assert with confidence that the chances are that the disease will reappear at some point within the half even of that mile; and that is precisely the part at which the produce trade by sea with other States is carried on. So, also, all our sub-epidemics have begun either at retail produce stores in the suburbs, or at stables to which produce has been carried in quantity from those wharves. If I were asked with what goods danger of the spread of plague is greatest, I should have no hesitation in naming produce of all sorts, returned empties with packing still in them, and bundles of empty bags.

13. *Repeated infection of Sydney.*

In view of the evidence bearing on non-inherence of the infection in place, of that touching the interval between epizoötics, and of that just mentioned which bears on association between plague-rats and a particular class of merchandise, I express with confidence the opinion that the successive epidemics at Sydney have been due not to continuous, but to repeated infection, which has always taken place by sea, and which has generally been connected with the importation of produce. Usually, though not always, the infection must have come to us from neighbouring States, and no doubt we have sometimes returned it to them. Plague has been maintained in Australia, I think, chiefly by an unseen, but traceable, interchange of the infection between ports; but occasional contributions from foreign countries have, no doubt, assisted from time to time, since its first introduction to the Continent must have happened in that way.

IV. MODE OF INFECTION.

It is convenient at this point to consider very briefly the mode in which the infection is received by man.

1. *Inoculation.*

After pondering much that has been written on the pathology of plague, it appears to me that the evidence is greatly in favour of the view that its seat of election is the lymphatic system—a view which has been ably supported by Maximilian Herzog (the Plague; Bacteriology, Morbid Anatomy, and Histopathology: Bureau of Government Laboratories, Manila, 1904); and that it is in favour, further, of the view that the commonest mode of receiving the infection is by inoculation through the skin. This, therefore, seems to me to be the mode of infection to which epidemic plague is due. Other modes are known to have been effective occasionally. Such, for instance, is drop-infection.

The suggestion that plague might be taken by the digestive tract seems to have been first made by Wilm in his preliminary report on plague (Hongkong, dated 20th May, 1896); it was advocated by him in his later and better known paper (November, 1896). He based it on the signs observed at 30 out of 150 necropsies. They consisted in hæmorrhages under the mucous epithelium of the stomach or intestines, swelling of the lymphatic follicles and of Peyer's patches, and sometimes ulceration of the latter. He remarked that general injection of the intestinal mucous membrane was usually present, but in some cases the alterations mentioned were so prominent that they seemed to him to indicate a primary infection of the intestinal tract. No better evidence for this mode of infection has been adduced by the few writers who, from time to time, have since espoused it on precisely the same grounds; its slender character, and its compatibility with origin in toxæmia are apparent.

But he also supported his view by the successful results of his animal experiments, which he made by feeding either with cultivations or with the tissues of animals which had died of plague; in some of them the material was introduced into the stomach by means of a glass tube. These results, he said, meant more than those of inoculation experiments, because they approximated closely to natural conditions. But I would point out that a review of feeding experiments in general shows that success is more likely to attend on feeding with tissues than with cultures; and then, secondly, that such experiments by no means approximate to natural conditions, and at best could never be brought to explain epidemic plague. For the only source from which the food of man could receive the infection sufficiently often must be from the muzzles and mouths of rats, when it would be present in very small quantity, or from contact with their excreta, when it must be in exceedingly small quantity (unless the dung itself were swallowed, which, surely, could rarely happen); and these conditions differ from the experimental conditions in the crucial respect of quantity of the virus taken, if in no other. But they do differ in another respect. It is that the virus administered in the cultures and in the tissues was actually growing, and at the highest pitch of its activity; while the virus casually communicated to food must be in a state of declining vitality, for in competition with true saprophytes b. pestis rapidly becomes overgrown. It is true that Milton J. Rosenau's results (the Viability of Bacillus Pestis, Bulletin No. 4 of the United States Public Health and Marine Hospital Service, Washington, 1901), which agree with those of Tidswell at Sydney (Report, 1902, paragraphs 256–8), and of most other observers, show that the protected bacillus can persist outside the animal body during periods of time which vary with the conditions; but the judicious remark made by Passed-Assistant Surgeon H. D. Gettings should be always borne in mind—namely, that the conditions which obtain in daily life are not on all-fours with those under which exact laboratory experiments are conducted. And I would enforce it by reference to a practical consideration. Our "normal" results have yielded many cases in which workmen were plainly infected at their work-places. Now, these workmen carried their dinner with them in parcels in which it remained until dinner-time came round; and, therefore, although their food was eaten in an infected place it may not be assumed that it was ever exposed to infection. That considerable body of people could not have been infected by feeding.

Wilm's excellent paper is so often referred to as though it were of equal value in all respects that it seems not unnecessary to point out here—though with all respect—that while no other trustworthy observer has ever succeeded in isolating the bacillus from human fæces (in which, nevertheless, it must often be present), he stated that his "culture examinations of fæces gave positive results in all of the fifteen cases examined, where well-marked enteric symptoms were present" (first report, p. 3, *e*).

2. *The bacillus in the blood-stream.*

In accordance with that view is Tidswell's experience that the bacillus is rarely to be found in the peripheral blood-stream before the agonal stage of the disease, in which he agrees with the great majority of careful observers, among whom the Bombay Plague Committee (*vide* supra, the Bombay Plague, 1900, p. 102), Calvert working at Manila (1900–1), and Powell working at Bombay (1904), may be specially mentioned. His method was to incubate the blood in the Widal pipette in which it had been collected for twenty-four hours before examining it. It should be noted that the possibility of cultivating the bacillus in blood *in vitro* does not warrant an inference that it can proliferate in the blood *intra vitam.*

3. *Mechanism of inoculation.*

The means by which the bacillus comes to be inoculated into man has generally been assumed to be by contact between deposited infection and the skin; and it will be remembered that such contact was at first supposed by some to be the cause of preponderance of buboes in the groin in people who habitually went barefoot.

Lowson (Report on the Bombay Epidemic, from 22nd February to 16th July, 1897; by James Lowson, M.B., Hongkong Civil Service, Plague Commissioner to Bombay) had already pointed out in 1897 that the same preponderance was observed among soldiers on plague duty who wore boots (p. 13); and in 1900 we found that no less than 73 per cent of the 286 fully-clothed persons who exhibited buboes had them in the groin. This surmise has now been almost given up.

Tidswell, after having repeated the experiment of Albrecht and Gohn of the Austrian Plague Commission in India on inoculation by application of plague-cultures to the shaved skin of guinea pigs, reached conclusions which warrant the following statement:—(*a*) Before infection can take place in that way there must be a breach of the epithelium, though not a bleeding wound; and (*b*) that breach must be recent, for it becomes repaired in about 24 hours so that infection by that channel can no longer be effected. Those are two limitations which attach to man; but now let the other side of the matter be considered. First, in order to contribute effectively to cause epidemic plague in this way the infection must be deposited by the rat on objects with which man is likely to come into contact; and, secondly, on such objects it does not survive more than three, or perhaps, four days as a rule, and that only when it is protected from the competition for life of saprophytes to which, of course, it is exposed under the circumstances now contemplated. There then, already, are four conditions which must be fulfilled before infection through the skin can take place; and what is more they must be concurrently fulfilled within narrow limits of time. But there is yet another consideration of weight. It is that rats, after all, could thus infect only some few small spots, even in a room; so that when the four conditions have been fulfilled within the requisite time, still the chances are greatly against accidental apposition between that small part of the body which has been injured, and those small spots in a room which have been infected. I believe it will not be thought necessary that more should be said in order to show that epidemic plague, though it be caused by inoculation, cannot be caused by accidental contact between the skin and deposited infection.

V. ASSOCIATION OF EPIDEMIC AND EPIZOÖTIC PLAGUE.

1. *There is a relationship in time and place between plague in rat and plague in man.*

The result of continuous examination of our rats has been to show us that rat plague always coincides in place with plague in man, and in time always precedes it; but the presence of plague rats was not always attended by plague in man. If, however, infection of the rat be a necessary condition of epidemic plague, a closer connection between plague rat and man should be traceable. Accordingly, house association between the two was often discovered. But often, on the one hand, it could not be discovered; and, on the other, often when it was discovered it was not attended by cases in man. Further, the commonly accepted observation that actual contact with the plague rat is unnecessary to infection of man was corroborated, and as a matter of observation was learned to have occurred very rarely. Moreover, such contact when it had occurred, was generally not followed by infection; and that, it will be observed, was in accord with a very extensive laboratory experience which shows that the many persons who now habitually dissect plague rats invariably escape infection, provided they do not wound themselves with their scissors and needles. The contradictory character of these several observations stands forth. The unavoidable inference from them is that if epizoötic plague is a condition precedent of epidemic plague, yet the plague-rat cannot be the only factor concerned. By itself the plague-rat is impotent. Neverthelss, I do not doubt that it is a necessary factor. Indeed, I see strong reason for regarding plague as a disease which belongs to, or primarily affects, the rat; for no ascertained fact has ever shown that it can originate with any other animal than the rat, nor that it ever prevails in truly epizoötic form among any other kind, save one. The exception is a species of marmot (Arctomys Bobac, spermophilus), which is indigenous to Mongolia; but that can have no *direct* bearing on our subject (*see* Zabolotny, Annales de l'Institut Pasteur, XIII, p. 838).

2. *An interval elapses between the beginning of epizoötics and attack of man.*

Let us then survey the epidemic phenomena in hope of finding help in one of them towards solution of the puzzling problem which our "normal" results have disclosed. Out of many things which have been asserted of plagae as the result of incomplete observation, occurrence of an interval between attack of the rat and attack of man stands out as a reality. We have seen it constantly; but we have also seen that it need not be long, as is generally asserted, but may be quite short.

The occurrence of a definite interval is well exemplified by the following observations. We have good reason for believing that our rats were dying of plague on the first occasion during the first week of January, 1900, and that they had probably become infected some time before; but the first case was not attacked till 19th January, the second not until 17th February; and the disease did not become widespread till two or three weeks later still. In the second outbreak immediately after the first case had been notified we ascertained that the infection was already present at three or four separate points; namely, at the produce store at which the patient had been employed, at a wharf where produce was habitually handled, and soon afterwards at another produce store, and at a stable a few hundred yards from it, all the latter having stood a little way inland of the wharf—"*mauka* of it," as the convenient phrase runs in the territory of Hawaii—and all having probably been infected *per saltum* from it. Yet there was an interval of thirty-four days between that first case and the second, and of thirty-five days between the second and the third. In 1903 the epizoötic was recognised on 12th May; but the first of the only two cases which followed was not attacked till 17th June. On the fourth occasion the epizoötic began 29th February at a certain produce store; the first person was attacked 9th March at that store, whence he had removed dead rats as late as 3rd March, and where others were afterwards found and plague in them identified; but the second case did not follow until thirty-two days later. I need not continue the series, for I can say that an interval was observed on every occasion, both in districts and in houses.

3. *Evidence that rats must die before man can be attacked.*

Of this interval many mysterious things have been alleged; but I believe it is now hardly necessary to point out that the first step towards explanation of it lies in recognition of the simple requirement that time must elapse before the rats, which are usually first infected at such uninhabited places as wharves, &c., can sufficiently penetrate to the dwellings of man. But another condition contributes to lengthen it, which cannot be so easily explained. An interval is always observed even between the invasion of individual houses and the occurrence of cases in them. Now, the difficulty of *identifying* plague in rats has already been mentioned. It has arisen in this, that however soon after attack cases have been notified dead rats have been found, and usually they have been found in an advanced stage of putridity. Of this I could furnish very many specific instances, did not time press. It is the common rule. Occasionally prompt notification has led to the discovery of fresh carcases; but always some of the rats found have died already. Plague cases do not occur till rats have died of plague in the house, or in its immediate neighbourhood; then, and not till then, may man be attacked. We shall make acquaintance with what I believe to be the reason for this almost directly.

4. *Seasonal incidence of plague.*

With assistance of the first four outbreaks the seasonal incidence of plague at Sydney can be fixed. The first or crude statement is the following: The first epizoötic began with January, and the last plague-rat was identified in August; the second began in November, and the last plague-rat was identified in July; the third began in May and ended in August; the fourth began in March and ended at the beginning of December. But it requires some adjustment as to the beginning of the second and the end of the fourth outbreak. Although infection of the rats began in November, and evidence of it was found on four separate premises during the latter half of that month, no further evidence of it was got, notwithstanding continuous search, until the middle of January; in other words nothing that could be called an epizoötic then existed. The period of wide-spread plague in the rats did not set in until about the beginning of February. And as to the end of the fourth, although it actually fell in December, still the end of that which could be called an epizoötic prevalence clearly fell in September; the plague-rats identified during the three latter months of that year, numbered only five, two, and one respectively. So that the epizoötic period may be fixed as falling between February and August, there or thereabouts.

And the height of the epidemic period coincided nearly with the height of the epizoötic; March, April, and May, were the months in which the disease was most active in both forms—that is to say, in as far as we could estimate the smaller fluctuations of the latter.

I would here point out again, that collection of plague-rats is never complete, nor nearly complete (unless on board empty ships), and that the numbers collected cannot be taken to indicate inferentially the proportional severity of the epizoötic. The rat-curves so frequently presented cannot be relied upon; they indicate the activity of the search perhaps, and may show its success; or they may only testify to the enterprise and cunning of natives who have brought rats in from outlying places for the sake of a reward.

VI. The Flea and Epidemic Plague.

1. *Necessity for a living intermediary between man and rat.*

The results of "normal" observation, which I have now described, have explained nothing. They have served only to establish a series of contradictions. For instance, while it appears on the one hand that the infection is not diffused by fomites, on the other it has been credibly reported from other parts of the world where the conditions of life differed somewhat from ours, that it has been seen to spread by that means, and not exceptionally. Again, while we have observed association between dead plague-rats and cases, we have seen reason in a small minority of instances for thinking that no plague-rats were present on premises which, nevertheless, had proved infective; more than that, it is quite clear that dead plague-rats are harmless to man. Then, when the presence of plague-rats on inhabited premises has been ascertained, examination of the result has revealed similar contradictions. We have seen that persons who resort to such premises are liable to receive the infection; and yet that association has proved entirely harmless very often indeed. Again, although in that association multiple cases have sometimes occurred, by far the most often only one person has been attacked out of many exposed. I need not adduce more examples. The contradictory character of these and of other events ascertained by us is striking; and it appears from them—a very important point—that the familiar crude observation of local coincidence between rat plague and human-plague, which is logically incompetent to establish causality as between rat and man, turns out to be quite incompetent in fact also as soon as it is examined by the epidemiological method. Indeed, when the crude coincidence is taken together with the contradictions, the resultant evidence strongly suggests that both man and rat take plague independently of each other, from some common source. So far, however, one consideration has been omitted which, in my opinion, has not received due recognition. This, broadly stated, is that the infection has been found external to man's body only in the bodies of the lower animals. Notwithstanding appearances, therefore, it must be that man receives the infection from the rat, although, as we know, the dead rat is certainly impotent to infect him. The crucial question, then, is how it comes to be communicated. Now, *the intermediation of some insect which has the power of taking it from the rat and of inoculating it into man, and which can retain the latter power for a considerable, and perhaps for a rather long, time, is the only means consonant with all the established phenomena which can be imagined.*

2. *Why the living intermediary must be the flea.*

By induction we had reached this stage in 1902. As soon as we had satisfied ourselves that an insect intermediary was necessary, we reviewed our notes to learn which insect was concerned, if perchance they might furnish a hint. I need not detain you with a long description of the search. We found 12 cases in the 1902 series—and more might have been found in the series of 1900 had the notes for that year been sufficiently full, since we found more after 1902—in which solitary buboes, situated in the femoral chain (resultant, therefore, from inoculation in the lower extremity) were exhibited by persons who had certainly received the infection at their work places. There they were all clothed. Their lower extremities were thoroughly well protected, at all events from casual contact with deposited infection, by boots and socks or stockings, and by trousers or petticoats, while their hands, arms, and faces, and sometimes their chests too, no doubt, were fully exposed. Yet they were not inoculated in those exposed parts, but in their protected parts. These cases showed that inoculation must have been effected by some agent to which neither the clothes nor the epithelium offered serious obstacles; by some agent which could evade the one, and which could penetrate the other without causing either noticeable pain or a visible wound. It was perceived, of course, that the flea alone answered these requirements; and then that fleas, which commonly breed within houses in the dust in corners, and in the cracks between flooring-boards, notoriously reach the legs first in places where they are numerous.

3. *What is the characteristic of the season of danger?*

We have seen already that the greatest prevalence of epidemic plague has occurred with us during March, April, and May. The season of danger, which equally includes the time when it is most difficult to arrest epizoötic plague, may be fixed, then, as being the autumn; for with us midsummer falls in December, midwinter in June. That is the season when most people suffer, and when rats most suffer. It is also the season of fleas. From about February onwards is the time when sandy patches, far removed from dwellings, begin to swarm with them; when domestic dogs are worried by the species which infests them as at no other time of year; and when one or other of the rooms in many a house which is neither dark nor dirty, but often of the better class, becomes for a time overrun with them. But although the months referred to are the time of special prevalence of fleas and of their more general obtrusiveness, it must not be forgotten that these insects are to be found all the year round, and in numbers in the warm, dark, places where they best breed.

The more important points in the history of the flea-hypothesis are much as follows:—In 1897 Ogata communicated plague to mice by inoculating them with crushed fleas taken from infected rats (Ogata, Cent. f. Bakt., XXI). In 1898 Simond (Annales de l'Institut Pasteur, XII) formally espoused the hypothesis in a summary of his Indian experiences. He supported it by reference to epidemiological, clinical, and experimental observations, which did infinite credit to his acuteness and penetration in many respects; but the epidemiological portion was (perhaps necessarily in his circumstances) unconvincing; his clinical observation of the frequent presence of reaction at the assumed point of inoculation in man has not been confirmed, although it was seen in 4 cases out of a very large number observed at Bombay (The Bombay Plague, &c., 1900, p. 104) and in one at Sydney (Report 1900, p. 56); and his experimental evidence was seriously defective. Nevertheless, his paper furnished ample ground for hopeful investigation on the lines indicated by him, and this we undertook with the results which have been described in our series of reports, and summarised in this paper. His experimental evidence consisted in successful repetition of Ogata's experiment, and in four experiments on the communication of plague from rat to rat by means of fleas. They resulted in infection with plague of 1 rat and 1 mouse; the species of the fleas used was not determined by him, but was probably *Ctenocephalus serraticeps*, since he took them from cats. In 1899 Nuttall (Johns Hopkins Hosp. Reports VIII) reported that several kinds of bacilli, among which plague was not included, soon lost their virulence in the flea's stomach, and he failed to communicate plague by means of bugs (*Cimex lectularius*). In 1900 Galli-Valerio (Cent. f. Bakt., XXVII) made some examination of the question which had been raised whether rat fleas would bite man, and concluded that neither *Typhlopsylla musculi* nor *P. fasciatus* (*Ceratophyllus fasciatus*) would do so. He remarked that *Ct. serraticeps* was rarely found on the rat; this our experiences in the same year (Report 1900, p. 40) did not contradict, and we now know it to be the case with our rats. Tiraboschi (Arch. f. Hyg. XLVI) also carried out a long series of experiments with *C. fasciatus*, *Ctenopsylla musculi*, and some other less common species, and concluded that neither of them would bite man, but on the contrary showed positive distaste for his skin, although starving. In 1901 Kolle (Zeitsch f. Hyg. XXXVI) made many attempts to communicate plague from rat to rat by this means without success. In 1902 Zirolia, after having worked at Rome with a strain of plague derived from Naples, published a preliminary note (Der Pestbacillus in Organismus der Flohe; Cent. f. Bak., XXXI) in which he said he had observed that B. pestis not merely survived in fleas for seven or eight days, but multiplied and preserved its virulence. In the same year Tidswell successfully performed Ogata's experiment, and he also discovered that *P. pallidus* was the common rat flea in Australia (*P. Cheopis* Roths.). This species has since been ascertained to be the common rat flea in India. He found further that both that species and our *C. fasciatus* would bite man, if only they were starved; this experiment was carried out as in mosquito feeding, namely, the fleas were placed in test-tubes, the mouths of which were closed by fine gauze through which they bit. In 1903 Gauthier et Raybaud (Revue d'Hygiene, XXV) made the same observation with *C. fasciatus* and (perhaps) with *P. pallidus* at Marseilles; and they succeeded in communicating plague from rat to rat by fleas in five instances (*C. fasciatus*). Galli-Valerio (Cent. f. Bakt., XXXIII) returned to the subject, reiterated his opinion that rat fleas would not bite man, and adversely criticised Raybaud et Gauthier's work. In February, 1905 (*Indian Medical Gazette*, February, 1905, p. 43), Liston suggested that the bacillus of plague must be transferred from rat to man as a condition of its continued existence; and Hankin, in 1906 (Journal of Hygiene, VI), described his dissection of the stomach of a flea which had been taken from the carcase of a plague-free rat found dead during progress of an epidemic of plague. From one half of the stomach he got a pure cultivation of *B. pestis*, as shown by involution forms on salt-agar, &c.; in the other half he observed bacilli with rounded ends which resembled *B. pestis*, in groups of about twelve each; from which he inferred that they were growing there, and on their way to reach the salivary apparatus. These two latter suggestions do not seem very probable, for *B. pestis* is a schizomycete. In 1905 Simond (*La question du véhicule de la peste*; Rev. Médicale du Brésil, 1905) expressed his opinion that *Ct. serraticeps* was, for several reasons, probably the species which most generally acted as agent; our observations have not supported that view, for, as has been noted by us (Reports 1900, 1902), it has been found on our rats but rarely.

4. *Fleas leave their proper hosts for other kinds of animals.*

It is well known that different species of fleas have their proper hosts, and prefer them to other kinds of animals. Human fleas do not *infest* rats, and rat fleas do not *infest* man; were it otherwise the rule, perhaps, would be to find multiple cases in plague-houses instead, as is the case, of finding only one person infected out of several equally exposed to the danger. Why, then, should it be supposed that rat fleas will leave the rat for man? In 1905 Liston (ubi cit. supra) made the suggestion that they remain with their proper host as long as it is available, and when it dies, or is withdrawn, proceeds to seek food from the next nearest animal; and he supported it with some interesting observations. He mentioned two instances in which dogs and cats seemed to have saved their owners from attack by *Ct. serraticeps* as long as they were present to afford food; but as soon as they had been withdrawn their owners were bitten. This accords with an observation of my own, namely, although pet dogs are tormented with fleas at the proper season, their mistresses, in whose laps they lie, are not (or very rarely are) attacked. But Liston was able to adduce further and more direct evidence. Rats having died of plague in a public garden at Bombay near a cage of guinea pigs, presently the latter began to die of plague; and on searching the survivors he was able to collect from them a good many specimens of *P. pallidus* (P. *Cheopis*, Roths.), which in Bombay and in Australia is the common rat flea, although guinea pigs in India (and in Australia) seldom possess any fleas at all, and when they do so harbour only one or two specimens of *Ct. serraticeps.* He observed also transfer of the common rat flea from rat to man. His attention was drawn to people who had been expelled from their house by the attacks of fleas. It appeared that on the 6th or 7th of a month the rats in the house had begun to die of plague; on the 11th fleas became so troublesome that the people had to sleep out on the veranda; on the 17th one of them fell ill with plague, and after him another. On the 20th Liston collected thirty fleas on the bodies of the remaining persons. As many as fourteen of them were of the species *P. pallidus*; yet among 246 fleas collected by him from the clothes of various persons under ordinary conditions, but a single specimen of *P. pallidus* was found. May this indicate the reason of our observation that man takes plague only after rats have died of it?

5. *Power of any kind of flea to communicate plague not rigorously established as yet.*

Direct experimental proof of a satisfactory character that it is in the power of any species of fleas to communicate plague is at present wanting; and it should be observed that after it shall have been given, still the epidemiologist alone can say whether the disease actually is commonly so spread. I do not doubt that the experimental proof will be forthcoming some day, and it occurs to me that I shall most usefully conclude my remarks by pointing out the reason for that confidence. It lies in this: We did not test the hypothesis of the flea because it had been put forward; we observed epidemic plague, and then found ourselves obliged to turn to it for an explanation of the phenomena (see Report, Sydney, 1902, par. 299). Without it our "normal" results formed a heterogeneous collection of data which were either disconnected, or actually in conflict with each other; with it we found that those data easily fell into a concatenated series. Thus, to borrow from philosophical terminology, we arrived at a "theory of plague." That harmonious and complete reconciliation of all the observed phenomena certainly holds good at Sydney; and although the mode of diffusion of plague is likely enough to exhibit slight variations of detail under the different conditions which obtain in some other countries, in them also it must hold good in all essentials.

Sydney, 14th April, 1906.

[One Plan.]

Sydney: William Applegate Gullick, Government Printer.—1906.

1907.

Legislative Assembly.
NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

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On a Sixth Outbreak of Plague at Sydney, 1906.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,
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Printed under No. 1 *Report from Printing Committee,* 10 *July,* 1907.

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21 January, 1907.

Attack occurred on 12th July in the last case of plague in 1905, and the last plague-rat in 1905 was identified 5th December. In 1906 the first plague-rat was identified on 23rd January; attack occcurred in the first case in man on 12th March, 1906, in the last on 22nd December, 1906; and the last plague-rat was identified on 29th December, 1906. The total number of cases was 20, of which 8 were fatal. They occurred in connection with 12 places of employment, and with 18 residences. Of the fatal cases 3 were notified after death; one of these was a case of primary plague-pneumonia, and the same character was ascribed to one other connected with it, of which a history was alone available.

2. The period to be reviewed extended from 6th December, 1905, to 31st December, 1906, and it may be divided as follows:—The precedent plague-free period lasted from 6th December, 1905, to 22nd January, 1906; the epizoötic period from 23rd January to 29th December; and it cannot be said that there was any subsequent plague-free period, for the first plague-rat of 1907 was identified on 10th January.

3. During the precedent plague-free period, 6th December, 1905, to 22nd January, 1906, the Intelligence Staff delivered 2,077 rats, 1,148 mice, total 3,225, all of which were examined in the laboratories, and found to be plague-free.

4. During the epizoötic period, 23rd January to 29th December, 1906, the Intelligence Staff collected 16,849 rats, 10,882 mice, total 27,731, all of which were examined, and among which plague was identified in 135 rats and in 39 mice, total 174. Six other animals were referred for examination, namely, 1 dog, 4 cats, and 1 monkey, all of which were found to be free from plague-infection.

5. The number of rodents destroyed during the whole year, that is between the 1st January and 31st December, 1906, was 54,151 rats, 29,085 mice; total, 83,236. A reward for the carcases of rats and mice was again offered to the public, and was paid from 29th March to 31st December. The numbers paid for were: rats, 36,182; mice, 17,607; total, 53,789, none of which were examined. The numbers collected by the Intelligence Staff during the whole year were 17,965 rats, 11,478 mice, total, 29,447, all of which were examined.

6. The species of rats brought in by the Intelligence Staff were *M. rattus* (with *M. Alexandrinus rufus*), *M. decumanus*, and *M. musculus*, among which the carcases were distributed as follows:—*M. rattus*, 8,694; *M. decumanus*, 9,275; and *M. musculus*, 11,478. The percentages of each species to the total was—*M. rattus*, 29·52; *M. decumanus*, 31·49; *M. musculus*, 38·97.

7. During the epizoötic period alone, the numbers of each species in which plague was identified were—*M. rattus*, 89; *M. decumanus*, 46; and *M. musculus*, 39; and the percentage of the infected rodents to the total of each species examined was among *M. rattus*, ·34 per cent.; among *M. decumanus*, ·49 per cent.; and among *M. musculus*, 1·02 per cent.

The

8. The following abstracts, which have been arranged in the order of dates of notification, exhibit the salient features and circumstances of each case:—

Case A.

M.M., f., æt. 27, single, dressmaker. No former attack; not inoculated; no communication with any former case. Residence, Parramatta Road, Ryde; employment, American Skirt Co., 346, Kent-street, City; last at work, 12th March. Attack, 12th March, sudden, 8·30 a.m. at employment; first symptoms, vomiting, rigors, headache, backache, pain in right groin. Notified by Dr. A. M. Johnson, 12th, 3·30 p.m.; visited (R.J.M.) 4 p.m.; admitted Coast Hospital, 9 p.m.; discharged 3rd May; duration 53 days. Bubo, right inguinal, solitary; material drawn from bubo 13th March, cultures and inoculation-test, positive.

Rats.—Residence, no signs of infestation. Employment, on the day of attack removed a dead rat from beneath her seat, and stated that rats had been dying on the same floor for a week past, and that the place was infested with fleas. Between 12th and 16th March three or four carcases were discovered in one of which plague-infection was identified; a cat was also found dead, not examined.

Connected case.—None (but there was communication between the joists with No. 348, *see* below).

Case B.

A.J., f., æt. 19, single, tea-packer. Not inoculated; no former attack, was associated with cases at her employment. Residence, 59, Brown-street, St. Peter's; employment, Oriental Tea Co., 348, Kent-street, City; last at work, 10th March. Notified by Dr. G. H. Bohrsman, 15th March, mid-day; visited (R.J.M.) 12·45 p.m.; admitted to Coast Hospital, 5 p.m.; discharged, 14th April; duration of illness, 35 days. Attack, 10th March, sudden, 3 p.m.; first symptoms, extreme general malaise and feeling of fatigue; pain first felt in left groin, 13th March. Bubo, left femoral, solitary; films and cultures made with material abstracted from the bubo on the 15th, 17th, and 24th March, negative. Lesions on drainage area: two indistinct flea-bites on inner aspect of knee.

Rats.—At residence, no traces; at employment (see general account of this group of cases in the text). The floor on which the patient worked was so overrun by fleas that the continual irritation was said to have interfered with work.

Connected cases.—Was associated at work with cases C and E at or after their attack.

Case C.

B.W., f., æt. 20, single, tea-packer. Not inoculated; no former attack; in contact at work with cases at her place of employment. Residence, 32, Balfour-street, George-street West; employment, Oriental Tea Co., 348, Kent-street; last employed, 12th March. Notified by the Assistant Medical Officer of Government (Dr. R. J. Millard, M.B. Syd., D.P.H.), in the course of investigating Case B, 15th March, 4·30 p.m.; admitted to Coast Hospital, 16th March; discharged, 14th April; duration of illness, 36 days. Attack, 9th March, evening, headache; 10th, continued malaise, but worked; 11th, Sunday; 12th went to work, but in the course of the morning had a rigor, went to bed, at night first felt pain in right groin; 13th and 14th, remained at home; 15th, sought advice at the out-patient department of a hospital. Bubo, right femoral, solitary; films, cultures, and inoculation-test, positive. Lesions of drainage area, several flea-bites.

Rats.—At residence; no signs of present infestation, one old rat-hole in kitchen. At employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with Cases E and F at or after their attack.

Case D.

C.L., m., æt. 21, single, tea-packer. Not inoculated; no previous attack; in contact with cases at her place of employment. Residence, 84, Rose-street, Darlington; employment, Oriental Tea Co., 348, Kent-street, City; last employed, 15th March. Notified by Dr. R. Davies, 16th March, 9 30 a.m.; visited (R.J.M.) 11 a.m.; admitted to Coast Hospital, 4·30 p.m.; discharged, 9th April; duration of illness, 29 days. Attack, 12th March, morning, feverish with headache; worked 13th, and on 14th until 11 a.m.; returned to work 15th, and at 9 a.m. first noticed pain in left groin, but continued at work; consulted Dr. Davies during the evening. Bubo, left femoral, solitary; films and cultures (16th March) negative, culture and inoculation-test (17th March), positive. Lesions of drainage area; a few fading flea-bites, inner surface of left knee.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with cases B, C, E, F, at or after their attack.

Case E.

E.E., f., æt. 23, single, tea-packer. Not inoculated; no previous attack; in contact with a case at her place of employment. Residence, 31, Nithsdale-street, City; employment, Oriental Tea Co., 348, Kent-street; last employed, 9th March. Notified by the Assistant Medical Officer of Government (Dr. R. J. Millard) in the course of investigating this group of cases, 16th March, 2 p.m.; admitted to Coast Hospital, 7·30 p.m.; discharged, 18th April; duration of illness, 41 days. Attack, 9th March, morning, while at work; strained herself in getting up from her seat, and immediately afterwards felt a sharp pain in right groin which obliged her to cease work; little constitutional disturbance, no headache, no vomiting; when visited, 16th, was dressed, and writing a letter. Bubo, right femoral, a large mass which included several glands, with much periadenitic effusion which filled Scarpa's triangle, only slightly tender; films, cultures, and inoculation-test, positive. Lesions of drainage area, numerous fading flea-bites.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with Case C after attack.

CASE F

A.W.B., m., æt. 40, married, book-keeper. No former attack; inoculated Sydney, 1900; at work on same premises with other cases after commencement of their illnesses. Residence, 231, Ernest-street, North Sydney; employment, Oriental Tea Co., 348, Kent-street, City; last employed, 10th March. Notified by the Assistant Medical Officer of the Government (Dr. R. J. Millard) in the course of investigating this group of cases, 16th March, 4·15 p.m.; not removed to Hospital. Attack, 10th March; felt tired throughout the day, and at night noticed a painful lump in the right groin, without any headache, vomiting, or shivering; stayed in bed, 11th, 12th, and 13th, got up 14th; was never very ill. Bubo, right inguinal, two glands, with periadenitic effusion, not tender; films, negative. Lesions of drainage area, none.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was at work in the same house as Cases B, C, D, and E, at or after their attack.

CASE G.

R.C., m., æt. 36, married, member of City plague-staff. No former attack; not inoculated; no communication with any previous case. Residence, 54, Thompson-street, City; employment, 346 and 348, Kent-street, between 12th and 16th March. Notified by Medical Officer of Health, Metropolitan district (Dr. W. G. Armstrong, M.B., D.P.H.), 17th March, 11 a.m.; admitted to Coast Hospital, 3·30 p.m.; discharged, 3rd May; duration, 49 days. Attack, 16th March, 5 p.m., pain in left groin, half-an-hour later a rigor, later and during the night headache and vomiting. Bubo, left femoral; films and cultures, positive; lesions of drainage area, several flea-bites on the left leg.

Rats.—At residence, no signs; at employment, *see* general description of this group of cases in the text.

Connected cases.—None.

CASE H.

T.G.D., m., æt. 49, married, bricklayer. No former attack; not inoculated; no connection with any previous case. Residence, 8, Botany-road, Alexandria; employment (for three weeks preceding attack), house-building at Petersham, an uninfected suburb; last employed, 7th May. Notified from South Sydney Morgue by Dr. Palmer, 11th May; post-mortem attended by Dr. F. Tidswell. Right femoral gland enlarged and hemorrhagic, surrounded by sanious periadenitic effusion which extended into the pelvis and involved the iliac and lumbar glands. The lymphatic glands of the left groin, the axillæ, and the mesentery shared the general congestion, but were not hemorrhagic. Lesions of drainage area, none found. Films, culture, and inoculation test made with material from the bubo, all positive; films and cultures from right lumbar glands, spleen, heart's blood, and culture made with the urine, all positive.

Rats.—Residence; the cottage was in a small block of insanitary property, the whole of which was or recently had been very freely infested; at the cottage three, and next door two, carcases were found, but too far advanced in putrefaction for bacteriological examination. No suspicion attached to the place of employment, and nothing was found there. The next house to T.G.D.'s was occupied by a fried-fish seller, who also supplied his customers with "chips," and who got his potatoes from Darling Harbour produce wharves.

Connected cases.—None.

CASE I.

H.A.T., m., æt. 54, married, a rat-catcher (that is, had recently devoted himself to rat-catching for the sake of the capitation-money); last employed, 4th June. No former attack; not inoculated; no connection with any previous case. Residence, Paul's-lane, Waterloo; employment, irregular; some weeks before had been employed at Yabsley's box factory, 58, Harbour-street, in the Darling Harbour Wharf area, and more recently had trapped rats there as well as elsewhere in that neighbourhood (*see* Cases L and M below); nothing further was discovered concerning his movements. Notified by Dr. P. G. Cooley, 7th June, 4 p.m.; visited (R.J.M.) 4·30 p.m.; admitted to Coast Hospital, 8th June; died, 17th June; duration, 13 days. Attack, 5th June, sudden after waking in the morning, severe headache, rigors, vomiting; 6th, on awaking, found swelling in right groin. Bubo, right femoral, four glands involved; films, culture, and inoculation test positive. Lesions of drainage area: several punctate lesions on right leg, probably old flea-bites.

Rats.—At residence, no signs of present or past infestation.

Connected cases.—None.

CASE K.

V.P., m., æt. 39, single, labourer. No former attack; not inoculated; no connection with any previous case. Residence, 12, Winslow-street, North Sydney; employment, Lever Bros.' Soap-works, Balmain; last employed, 20th June. Notified by Dr. Devlin, 22nd June, 9 p.m.; visited (R.J.M.) 23rd, 9 a.m.; admitted to Coast Hospital, 23rd; died, 27th June; duration, 7 days. Attack, 20th June, sudden, 4·30 p.m., violent shivering, followed by severe headache; first complained of pain and swelling in left femoral chain afternoon of 22nd (but was already delirious). Bubo, femoral, solitary; films, culture, and inoculation test positive. Lesions of drainage area, some healed abrasions on the leg.

Rats.—At residence, no signs; at employment, prolonged search failed to reveal anything suspicious, except general signs of a moderate infestation; on and after the 16th patient had been employed with two others in removing a small mess-room, and there was evidence of stench experienced in course of the operations. The works stood in a neighbourhood where plague-rats have never been taken.

Connected cases.—None.

CASE L.

H.B., m., æt. 38, married, box-maker. Not inoculated; no former attack; no communication with any previous case. Residence, 38, Cowper-street, Glebe; employment, Yabsley's box-factory, 58, Harbour-street, Darling Harbour; last employed, 23rd June. Notified by Dr. A. A. Palmer, 25th June, 1 p.m.;

visited (R.J.M.) 2 p.m. ; admitted to Coast Hospital, 6·45 p.m. ; discharged, 28th July ; duration, 36 days. Attack, 23rd June, sudden, 8 p.m., shivering, headache, and a painful lump in left groin. Bubo, left inguinal, solitary ; films and cultures positive. Lesions of drainage area ; several flea-bites.

Rats :—At residence, no signs ; at employment, a responsible workman said he had picked up two dead rats and had killed two sick rats about 12th June, and in the course of cleansing 10 carcases were found, but all in an advanced stage of decomposition, and plague was not identified in any of them. A good many rats were trapped at the same time in adjoining and neighbouring premises, in none of which was plague identified. It was here that H.A.T. (Case I, see above) had trapped rats, but the available information referred to some date about the middle of April, or 6 or 8 weeks before his attack.

Connected Cases :—See Case M.

Case M.

J.B., f., æt. 38, housewife. Not inoculated ; no former attack ; not connected with any previous case. Residence and employment, 38 Cowper-street, Glebe. Notified by Dr. A. A. Palmer, 25th June ; visited (R.J.M.) 2 p.m. ; admitted to Coast Hospital, 6·45 p.m. ; discharged, 28th July ; duration, 36 days. Attack, 23rd June, sudden, at 8 p.m. (at the same moment as her husband, H.B., Case L), shivering, headache, general pains ; first noticed a small, painful lump in left femoral region, 25th. Bubo, right femoral ; material taken 26th and 28th, films and cultures negative. Lesions of drainage area, a few flea-bites. By the 28th the bubo had much diminished, and on 8th August had resolved.

Rats :—At residence, which patient had not left for many days before attack, no signs. Clinically this case was one of plague of moderate severity, nor was failure to demonstrate the bacillus in the bubo decisively against that diagnosis ; yet it would seem that the only possible source of infection must have been a flea imported to her house by her husband from the factory, which she herself had not visited. Her attack at precisely the same time as her husband is noteworthy and singular, but was ascertained to have occurred ; perhaps it may be taken, as far as it goes, in corroboration of the suggested mode of infection.

Connected Cases.—See Case L.

Cases N, O, and P.

These were cases of primary plague-pneumonia ; they are separately described in the text.

Case Q.

A.B., m., æt. 16, single, shipping clerk. ; no former attack ; not inoculated ; no communication with any previous case ; residence, Smith-street, Summer Hill ; employment, Slade & Co, 408 Kent-street, Darling Harbour area ; last employed, 3rd July. Notified by Dr. Pockley, 7th July ; visited (F.T.) same date ; admitted to Coast Hospital, 5 p.m. ; discharged, 15th August ; duration, 44 days. Attack, 3rd July, sudden, 2 p.m. ; first sign, pain in groin and discovery of a lump at the same time ; rigor during the evening. Bubo, left femoral ; films negative ; culture and inoculation, positive. Lesions of drainage-area, none made out.

Rats.—At residence, no signs ; at employment, no history, no evidence on search. During ten days preceding attack, had visited many wharves on business.

Connected Cases.—None.

Case R.

F.J.B., m., æt. 15, single, messenger ; not inoculated ; no former attack ; no connection with any preceding case ; residence, 116 Simmons-street, Enmore ; employment, out of place, looking for work. Notified by Dr. G. H. Bohrsman, 11th July, 1·10 p.m. ; visited (R.J.M.), 3·10 p.m. ; admitted to Coast Hospital, 8 p.m.; died 13th July ; duration, 48 hours. Attack, 10th July, sudden, at midday ; general pains and severe headache ; vomiting ; 11th, bubo first observed. Bubo, left, one inguinal and one femoral gland enlarged, small, very tender ; films made 11th July, negative ; p. m. spleen, films negative, culture positive (scanty growth) ; liver, films and culture positive (scanty growth) ; mesenteric glands, film and culture negative ; left femoral gland, films, culture, and inoculation-test, positive ; lesions of drainage-area, many flea-bites on inner side of thigh.

Rats.—Residence, in a poor area, in a very insanitary state ; there were signs of present infestion, but no carcases were found. Extensive cleansing of the block and neighbourhood resulted in identification of one plague rat at No. 118 (next door).

Connected Cases.—None.

Case S.

M.J.S., m., æt. 35, married, wharf-labourer ; residence, Herbert-street, Mortlake ; employment North Coast Co.'s wharf ; last employed, 14th July ; not inoculated ; no former attack ; no communication with any previous case. Notified by Dr. Heatherington, 22nd July, 2 p.m. ; visited (T.W.S.) 5 p.m. ; admitted to Coast Hospital, 23rd July ; discharged 15th August ; duration, 33 days. Attack gradual ; 14th July, tired and feverish after work ; 15th, better ; 16th, left work at noon, and then had general pains, rigors, and vomiting ; on 19th a pustule was first noticed over the right sterno-clavicular joint, which, on the 22nd, had a malignant aspect, and on the same date there was painful swelling of the epitrochlear gland, left arm ; films from pustule, positive ; films and culture from epitrochlear gland, positive ; lesions of drainage area, small healed abrasion on forearm.

Rats.—At residence, no signs of infestation ; at employment, this was an infested wharf at which plague rats were gathered from time to time between the middle of February and the end of August to the total number of 29 (*M. decumanus* and *rattus*).

Connected Cases.—None.

Case T.

R.G.F., m., æt. 35 years, married, storeman; not inoculated; no former attack; no connection with any previous case; residence, 485 Glenmore-road, Paddington; employment, Osborne and Jerdan, 393 George-street, city; last employed, 30th September. Notified by Dr. J. Morton, 6th October, 7·30 p.m.; visited (T.W.S.) 10 p.m.; admitted to Coast Hospital, 7th October, 11 a.m.; died, 7th October, 9 p.m.; duration, 6½ days. Attack, sudden, midday, 1st October; malaise, general pains, drowsiness; bubo first noticed, 5th; bubo, left epitrochlear gland, with subsequent enlargement of two axillary glands; films, cultures, and inoculation test, positive; lesion of drainage-area, a few slight abrasions.

Rats.—At residence, no signs of infestation; at employment, the basement, where patient worked, had a tar-paved floor which had been perforated by rats, of infestation with which there was abundant evidence; in course of cleansing, six carcases were found advanced in putrefaction, in which plague was consequently not demonstrable. Additionally, the patient had visited the North Coast Company's wharf to book parcels, on 26th September, at all events; this wharf was an infected place (see under Case S). The whole block was searched, and it appeared that rats were very scarce in it; but few were caught, and no plague rat was found.

Connected Cases.—None.

Case U.

J.J.J., m., æt. 38, married, storeman; not inoculated; no former attack; no communication with any previous case; residence, 31 Richards-avenue, City; employment, Mauri Bros. & Thompson, 46-8 York-street, City; last employed, 22nd December. Notified by Dr. Gledden, 26th December, 11.30 a.m.; visited (T.W.S.) 2.15 p.m.; admitted to Coast Hospital, 27th December; discharged, 21st January, 1907; duration, 31 days. Attack, 22nd December, sudden, 8.30 a.m.; headache and a lump in right groin discovered same time; bubo, right femoral; films, negative; cultures and inoculation-test, positive; lesions of drainage-area, none.

Rats.—At residence, no signs; at employment, no signs of infestation, no carcases, one live rat and two mice caught, all free from infection; rats very scarce in the whole block. Source of infection not discovered.

Connected Cases.—None.

There were three groups of associated cases, of which one consisted of Cases B, C, D, E, F, and G, together with which it will be well to consider Case A; another of Cases L and M, to which should probably be added Case I; and the third of cases N, O, and P. The circumstances under which these grouped cases occurred were the following:—

Case A, and Cases B, C, D, E, F, and G.

9. These cases occurred at 346 and at 348 Kent-street, city. The two buildings adjoined each other and were fine warehouses of identical design and construction; they had five floors, no basement, and at back a small paved yard for waggons, on which other buildings on the Kent-street frontage of the block opened, as well as some on the Clarence-street frontage (see diagram). No. 346 was occupied by a dressmaking company which employed a staff of thirty-five persons; No. 348 by tea merchants. The latter was used for the storage, repacking, and distribution of tea; seventy persons were employed there.

10. On 8th March it was reported to the local authority for the city of Sydney that rats had been dying on the third floor at No. 346 for about three days past, and rat-catchers were told off to investigate; they caught only a few rats which, on being examined in the laboratories of this Department, were not found to be infected. The medical officer of health for the metropolitan district (Dr. W. G. Armstrong, M.B., D.P.H.) thereupon directed search between ceilings and floors on 10th March, but no carcases were discovered until the 12th, when one in which plague was identified was found. On this date also M. M. (Case A) on reaching her room to begin work found a dead rat under her chair and removed it; plague was afterwards identified in it. Here no other cases occurred. During cleansing a dead cat was found one morning, but the carcase was not submitted.

11. The whole block in which these two warehouses stood had been under notice of the city rat staff since 28th February; and between 2nd and 8th March nine carcases had been referred to the laboratories, which had been taken at No. 348; all of them were ascertained to be plague-free. On 15th March the case of A. J., a girl employed as a tea-packer at No. 348 was notified; she had been attacked, 10th March. On inquiry at the warehouse it was found that others were absent from work, and ultimately that four of them had plague; their dates of attack were the 9th, 10th, and 12th. All the cases were of little severity, and all the patients recovered. Four of the five patients were employed on the third floor of the building and in one room; the fifth was the accountant, whose office was on the ground-floor. It was stated that dead rats had been found on the third floor on

several days before 15th March, and all hands agreed that this floor was so overrun with fleas that the irritation consequent on their attacks had impeded the transaction of business. It should be mentioned that the large building was not merely excellently constructed and in good repair but was also very well kept; no other fault could be found with it than the presence of ceilings, between which and the flooring-boards above them there were large accumulations of tea dust and some, but not much, rat rubbish. Search of all floors resulted in discovery of four carcases only and a few deserted nests; the former were too far advanced in putrefaction for bacteriological examination, and plague was not identified in any rat taken in this house.

12. In addition to these six cases a seventh (Case G) occurred in a member of the cleansing-gang, which had been put in to both warehouses on 12th March. The date of his attack was 16th March, and he recovered after an illness of moderate severity.

13. Reference to the diagram will show the situation of these premises in relation to others at which plague-rats had been previously identified, among which that of more immediate importance was 205 Clarence-street, where a plague rat had been found on 5th March, this having been one of the buildings on the eastern frontage of the block which had access to the cart yard at the back of 346–8 Kent-street on its western frontage. The rats taken on these three premises were all *M. rattus*; no *M. decumanus* was found. An attempt to secure fleas for classification failed, because all floors had been sprayed with an emulsion of tar acids (in the form known as "miscible carbolic") before searching and cleansing had been begun. In this connection it may be noted that such preliminary spraying appears to be the best protection to cleansing-gangs, and is always done immediately on entering premises believed to be infected, although in this instance it did not serve to protect R. C. (Case G.)

Cases L and M, and Case I.

14. H.B. was a boxmaker who worked at Yabsley's box factory, 58 Harbour-street, Darling Harbour. He lived in a small cottage in Cowper-street, Glebe, some three-quarters of a mile away, and his wife was the only other occupant. These two were shopping on the evening of Saturday, 23rd June, at 8 p.m., when both suddenly fell ill. Subsequently the infection was bacteriologically identified in material drawn from H.B's. bubo, but not in that from his wife's; her case, however, was very well marked clinically. Both patients recovered. At the box factory, information gathered from the employees, and the discovery of carcases, afforded sufficient evidence of epizoötic plague, although the stage of putrefaction in which the latter were found prevented demonstration of the cause of death. Thus H.B's. case was accounted for. But his wife had not visited the factory, and it was ascertained she had not been away from the street in which she lived for at least a week preceding the date of her attack; she had not been in communication with any preceding case or suspected case; and the whole neighbourhood of her dwelling had been and continued to be quite free from suspicion of infection, notwithstanding close search. The infection must have been conveyed to her by her husband; but it must also have been mechanically conveyed by him, since her illness began at the same moment as his. It may be assumed that his workplace carried the infection, that is to say, in the rats which infested it; but he had not taken home from it anything in which a rat might have lain concealed, and it has been amply shown in this series of reports (for the years 1900-2-3-4-5-6) that man does not become infected from deposited infection, such as might have been so discharged from rats at the factory that H.B. might conceivably have picked it up and carried it home in his clothes. If the ætiology of plague were still where we left it in 1903 (*see* Report, Sydney, 1900, p. 41. conclusion 1, and Report, Sydney, 1902, pars. 262-70) the supposition that the infecting agent must have been a flea carried home by H.B. would still be inevitable, and the curious simultaneity of the two attacks might perhaps be adduced in support of it. Any difficulty which might otherwise have been felt in accepting it, however, has been removed by the ample experimental demonstration that fleas can commonly act as the conveyors of the infection from infected rats to other animals, which has been afforded during the past year by the Plague Research Committee conjointly appointed by the India Office, the Royal Society, and the

Lister Institute. This result of the Committee's researches into agency of the flea, which were conducted under direction of Dr. Charles J. Martin, F.R.S., of the Lister Institute, formed the subject of an interim report which was published as a special number of the "Journal of Hygiene," in September, 1906.

15. As regards Case I, the detail notes above may be referred to. There was evidence of the patient's association with Yabsley's box factory several weeks before the date of his attack. His subsequent movements could not be ascertained, but it seemed quite likely that he had gone there to trap rats from time to time. The last date at which he could have been there—but nothing which showed that he had recently been there came to light—was 5th of June.

Cases N., O., and P.—Primary plague-pneumonia.

16. These three cases came to notice in connection with the death of the second patient; they are described below in the order in which they occurred. This form of plague had not previously been encountered in New South Wales.

17. *Case N.* (not examined either before or after death).—H. G., m. aet. 45, donkeyman on the coasting S.S. "Bega," where he had been regularly employed for the past ten years; residence, 8 Mort-street, Balmain. Married; the other occupants of the house were his wife (C. G., case O) and nine children, aged from 19 years to 6 months. The family was in comfortable circumstances, the house having been a cottage of one storey containing six or seven rooms, well-kept and furnished. G. was in the habit of returning home three times in each fortnight. On 15th June he had sailed from Sydney in the "Bega," being then in good health; he fell ill on the 17th at sea, and left work; he stayed off on the 18th; on the 19th he reached Sydney again early in the morning, and went home. Dr. F. visited him in the course of the day. He appeared to be suffering from catarrh, was visited again on the 20th, and was then thought to have recovered; Dr. F. left him without intention of calling again. But on 22nd June G. summoned Dr. D. late at night, when the presence of pneumonia was recognised; his T. was 100·5°, his pulse was good, and his condition caused no alarm. At 11 a.m. on the 23rd Dr. D. found him pulseless, respirations about 60, and cyanosed; he died very soon afterwards. It was ascertained that at some date, which could not be precisely fixed, but which was less than a week before his attack, G. had observed a dead rat on board the "Bega," which he had picked up with his hands and thrown overboard; for this imprudence he was scolded by the chief engineer, and when another carcase was found in the engine-room, at or about the same date, G. picked it up with tongs and cast it into the furnace. The first intimation of these cases having been received only on 29th June, after the "Bega" had on that day sailed from Sydney again, opportunity of examining the vessel did not occur till 3rd July. After she had been emptied, fumigation with burning sulphur was begun at 8 p.m. on the latter date. After hatches had been lifted on the 4th, thorough search of every part of the ship revealed the carcase of one rat only, which was not infected with plague, and showed that the vessel had been kept as free from rats as possible by the fumigation periodically carried out by the owners under my instructions. The last preceding fumigation had been done on 19th June, and it was reported by the manager that subsequent search had then discovered no rats and no carcases. During stay at Sydney the vessel usually visited two or three wharves, and habitually carried produce as well as empty sacks, crates, &c.; infected rats were being taken from time to time in the Darling Harbour area (*Cf.* the Table printed with the Diagram); and on the whole it seems most probable that the "Bega" acquired a plague-infected rat during her stay in port, with which G. was unfortunate enough to come into contact, although she was kept free from general infestation.

18. *Case O.*—C.G., f. aet. 37; wife of H.G. (Case N).—Mrs. G. had nursed her husband. She fell ill 26th June, and died at midnight on the 28th. On the 29th the medical man in attendance on her verbally reported his suspicion that she might have died of plague-pneumonia to the Department, and, as he had refused to certify to the cause of death, the Coroner, at my instance, directed removal of the body to a public dead-house for examination. It was dissected by the Government Pathologist and Second Government Medical Officer for Sydney (Dr. G. H. Taylor), who, among other details, reported of the lungs as follows:—There was a little recently effused lymph on the surface of the left pleura. An area of lung about the size of

a small orange in the left apex was consolidated, and the lung tissue around it was intensely congested and œdematous; below it there were numerous small pneumonic patches. The inferior lobe of the lung was much congested. In the lower lobe of the right lung there was a patch of consolidation similar in size and appearance to that in the left apex, which also had a zone of intensely-congested and œdematous lung-tissue. In this and the middle lobe there were numerous small pneumonic patches, and the remainder of the lung was intensely congested. The bronchial glands were soft and swollen, the bronchi deeply congested." In the laboratories it was found that films, cultures, and inoculation-tests made with lung tissue, all contained or yielded *B. pestis*, and it was noted that films prepared from the spleen furnished no evidence of plague-infection.

19. *Case P.*—S.R.M., f., æt. 39, married, housewife; residence, 39 Phillip-street, Balmain.—Attack sudden, 28th June, 7 a.m. Her case was notified, and she was visited, near midnight on the 29th. She was isolated at the Quarantine Station, North Head, 30th June, where she died during the evening of the same day. The body was examined by the Government Pathologist and Second Government Medical Officer for Sydney (Dr. G. H. Taylor), on 1st July, who reported that there was effusion of lymph over the left pleura, and a few minute hæmorrhages beneath it; there was grey hepatisation of the upper half of the superior lobe of the lung, the adjoining lung-tissue was œdematous and deeply congested; the inferior lobe contained numerous small pneumonic patches, and was intensely congested; the left bronchial glands were swollen and soft. The right lung was collapsed, but free from disease. At the laboratories, presence of *B. pestis* was identified in the lung-tissues by the usual methods. This patient's connection with the first of the preceding cases was intimate; she was with G. at times during his illness, and immediately before he died; she also viewed his body after death (24th or 25th). She was not with Mrs. G. after the latter had fallen ill on the 26th. The other occupants of her house were her husband and four children, aged from 17 to 3 years, all of whom were from time to time in her bedroom as long as she remained at home.

20. The mode of spread in primary plague-pneumonia is from person to person, through intermediary of saliva and of expectoration from the affected lungs. Usually this form is exceedingly contagious; many instances could be cited in which whole households have succumbed to it, or in which long trains of connected cases of it have occurred. Moreover, it is invariably, or almost always, fatal. And therefore, although isolation is but rarely necessitated by the circumstances in the bubonic and septicæmic forms of plague, it was essential to enforce it strictly and very promptly in connection with these cases of the pneumonic form. The diagnosis of C. G.'s case became known at 4.20 p.m. on 29th June; by 10 p.m. all the inhabitants of the G. house, together with many visitors to it, had been protected by subcutaneous injections of Yersin serum, and landed at the Maritime Quarantine Station, North Head, and the house had been quarantined in charge of the police. On that date also the M. household was similarly protected, and on the 30th was removed to the same place, the house itself, as well as another near it, being quarantined. On the same day a few more contacts were also sent down, and some persons whose connection with the cases was doubtful or slight were protected with injections of Yersin serum and placed under surveillance. Altogether 29 persons were isolated as contacts in connection with the G. and M. households; they were detained for five days and were then released. No further case occurred. It was ascertained that all three patients had very little cough; to this, I think, must be ascribed escape of their many young children, and of other persons who were freely exposed to them.

Destruction of Rats by Infection with Danysz's Rat-virus.

21. During past years three laboratory attempts have been made at the destruction of rats with imported strains of this organism, but without success. Dr. Danysz having arrived at Sydney to study a similar method of destroying rabbits, the opportunity was taken of making a further attempt under his supervision with virus which he had imported, had subsequently exalted to the requisite degree of virulence, and had been so kind as to place at my disposal. At his request a place was sought at which the results of its application in the field could be well-observed; and after a time, on suggestion of the Inspector-General of the Insane (Dr. Eric Sinclair, M.D.), I decided on the grounds of Gladesville Asylum, a large institution

for the insane, which consists of many ward, administrative, and farm buildings, separated from each other, and under close observation. The Acting Micro-biologist (Dr. R. J. Millard, M.B. Syd., D.P.H. Camb.) was directed to carry out the experiment, and he made the following report on its results :—

The virus used for this experiment was supplied by Dr. Danysz, who on 7th November last brought to the Laboratory from Broughton Island a pipette of blood from a rat which had died of the disease. This blood was on the same date sown into two tubes of ordinary broth, and on an agar slope, and incubated at 37 C. On 8th November, after twenty-four hours' incubation, the growth on agar proving to be a pure culture, one of the tubes of broth culture was distributed into six flasks—each 500 c.c.—of broth prepared according to Dr. Danysz' instructions, as follows :—

(1.) Take—

Lean beef, finely minced	500 grm.
Sodium chloride	5 „
Peptone (Witte)	1 „
Water	1,000 c.c.

Boil for two hours.

(2.) Decant the broth, and filter to remove the fat.

(3.) Mix the broth with the minced cooked meat. Render slightly alkaline to litmus paper by addition of caustic potash 10 % solution. Distribute into flasks. Sterilise.

November 8, 9.—The inseminated flasks were then incubated for twenty hours at 37 C.

On 9th November five of the flasks were taken by me to the Hospital for Insane at Gladesville, and baits were there prepared by soaking small cubes of stale bread in the mixture of broth and minced meat. The sixth flask was retained at the Laboratory to be administered to rats in cages, as controls.

Suitable spots on the hospital premises having been chosen by me, the placing of the baits was entrusted to an experienced rat-catcher (Allen) in the employ of the Department, who placed the baits in the evening, and examined them early next morning.

Details of this distribution were as follows :—

	Baits laid, 9/11/06.	Baits taken, 10/11/06.
Kitchen and surroundings	52	14
Stables	10	0
Boatshed and surroundings	36	31
Night-soil pit No. 1	14	6
„ „ No. 2	50	49
Piggery feed-room	12	2
Lower entrance to piggery (a roadway on rough stone "made" ground), ...	70	64
Totals	244	166

The "night-soil pits" are large trenches about 60 feet by 18 feet, and about 5 feet deep, in which night-soil from the hospital pail closets is deposited, mixed with earth and garden sweepings, there to remain until it is fit for use as manure. The pits are remote from the hospital buildings, in a large paddock forming part of the farm. At my visit during the afternoon I saw numerous rats here, and the sides of the pits were riddled with rat-holes.

The "lower entrance to the pig-yard" adjoins an excavation into which manure and other rubbish is tipped. Here the rats were even more numerous than at the night-soil pits, and could be seen in broad daylight running about among the stones.

The Assistant Superintendent of the Institution (Mr. Lewis) interested himself in the experiment, and undertook to have these spots kept under daily observation as to mortality amongst or diminution of rats, and to forward for examination at this Laboratory any dead rats that might be found.

Details of the rats fed as controls at the Laboratory are as follows :—

RAT No. 1,401 (*M. rattus*).

9 November, 1906—Fed on bread soaked in broth culture.
10 „ „ —Most of bread eaten.
12 „ „ —Escaped by gnawing through wire of cage.
14 „ „ —A rat similar to, and probably identical with, 1,401 trapped in Laboratory yard and killed.

P.M.—Liver enlarged, with some small areas of necrosis.
Culture from liver and spleen mixed, but Danysz' rat bacillus was isolated from each.

RAT No. 1,402 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
17 „ „ —Observed to be sick.
19 „ „ (Monday)—Dead at 9 a.m.

P.M.—Liver and spleen deeply congested ; large intestine inflamed ; heart dark and injected ; lungs normal.

Heart blood yielded a pure culture of the Danysz rat bacillus. Pipettes of this blood were used in preparing fresh batch of broth.

RAT No. 1,403 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
No apparent effect down to date of killing.
30 „ „ —Killed and examined. No evidence found of infection.

RAT No. 1,404 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
17 „ „ —Observed to be sick.
19 „ „ (Monday)—Dead at 9 a.m.

P.M.—Changes similar to those found in rat No. 1,402. Culture from heart blood was a mixed growth of the Danysz rat bacillus and a large sporing (putrefactive) bacillus.

Thus of the four control rats, two died in nine days, one suffered no ill effects of the feeding with infected broth, and the fourth was infected and would possibly have died of the infection if it had not been killed.

Four other rats were now fed and inoculated as follows :—

RAT No. 1,409 (*M. rattus*).

19 November, 1906—Fed with body of rat No. 1,404.
23 „ „ —Escaped from cage.
27 „ „ —Trapped and killed.

P.M.—Culture from heart blood, liver and spleen gave negative results.

RAT No. 1,410 (*M. rattus*).

19 November, 1906—Fed with body of rat No. 1,402.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

RAT No. 1,411 (*M. rattus*).

19 November, 1906—Inoculated in the right thigh with heart blood of rat No. 1,402.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

RAT No. 1.412 (*M. rattus*).

19 November, 1906—Inoculated in the right thigh with heart blood of rat No. 1,404.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

At Gladesville the evidence of sickness amongst the rats was meagre. On 18th or 19th November a sick rat was seen by an attendant and killed at the night-soil pits, but through some misunderstanding this specimen was not sent to the Laboratory to be examined. I had made a careful inspection of the various spots two days before, on the 16th, and had found the rats then much in evidence, and apparently as numerous as ever.

On the 21st November, during a second distribution of baits, it was observed that many of the rat-runs at the night-soil pits had apparently not been recently used. Elsewhere no change was noticed. On the 22nd there were examined at the Laboratory seven rats (*M. decumanus*) from Gladesville, of which three had been found dead near the pig-yard entrance, and four had been trapped and killed. The three found dead were putrid, and a satisfactory examination could not be made. Of the trapped rats, three were apparently normal. The fourth, however, had the liver and spleen enlarged and congested, and a pure culture of the Danysz bacillus was obtained from the spleen.

On 21st November a second distribution of baits was made at Gladesville. The virus of these had been prepared in the same way as for the first distribution. A broth culture was made from the heart blood of rat No. 1,402 and this broth was sown into flasks of Dr. Danysz' medium, which were then incubated at 37° C. for twenty-four hours. In all 588 baits were distributed on this occasion as follows:—

	Baits laid, 21/11/06.	Baits taken, 22/11/06.
Night-soil pit No. 1	40	10
„ No. 2	60	25
„ No. 3	12	5
„ No. 4	60	20
Rubbish tip	100	90
Farm attendant's cottage	16	16
Lower entrance to pig-yard	300	200
Totals	588	366

On the same date corn, mixed with this infected broth, was fed to two rats in cages at the laboratory, details of which are as follows:—

RAT No. 1,413 (*Rattus*) and RAT No. 1,414 (*Rattus*).

21 December, 1906.—Fed on corn mixed with infected broth.

4 December, 1906.—No ill-effects have followed. Killed. No evidence ef infection.

At Gladesville no more sick or dead rats were found. Inspections were made by me on 25th November, and 9th December, when I found at the lower entrance to the pig-yard the rats were still numerous, but saw none at the night-soil pits. On December 14th and 15th, Rat-catcher Allen made a thorough inspection of these spots in the late evening and early morning, and found:—

At Nightsoil Pits.—Burrows deserted, and in many cases overgrown with cobwebs. Rats still resort to these pits to feed, as he saw from a rubble wall of a dam some 250 yards away, but they have apparently abandoned their burrows here.

At Lower Entrance to Pig-yard.—Many of the rat-runs show similar evidence of disuse. Rats are still numerous, but he believes that they come from a distance to feed here, and no longer live here in such numbers as before.

At the same time he trapped eight rats (*M. decumanus*) at these places, but none showed any evidence of infection.

Summary.—The experiment cannot be considered a satisfactory demonstration of the efficacy claimed for the Danysz Rat Virus.

The first batch of virus when fed to four control rats killed two in nine days, and infected a third, which unfortunately had to be killed, but the fourth rat, though he ate the virus, was not infected. Baits prepared with this first batch of virus distributed at Gladesville, infected some of the rats and probably caused some rat mortality, but evidently did not set up an epizoötic of any magnitude.

Attempts to hand on the disease by feeding the dead bodies of the infected rats, and cultures made from heart's blood of these, and even by injecting this blood, were uniformly unsuccessful, and it is doubtful if any result followed the second distribution of infected baits at Gladesville.

These negative results indicate a rapid loss of virulence, which must be obviated if this virus is to be of practical utility for rat destruction.

Note.—The following is a brief description of the bacillus under discussion:

Morphology.—A small cocco bacillus, with some long rod forms. Actively motile. Gram negative.

Culture.—On agar, produces a moist, creamy growth. Gelatine not liquified. In broth, a a general turbidity and serum. On potato, a transparent, moist growth. Litmus milk becomes slightly acid in twenty-four hours, then alkaline. In peptone water no indol is produced. On glucose, acid without gas, and in glucose, neutral red fluorescence is produced. There is no fermentation of lactose or saccharose.

22. Plague rats were identified during 1906, on forty-eight premises, of which a large majority were as usual either wharves on the Darling Harbour wharf-line,

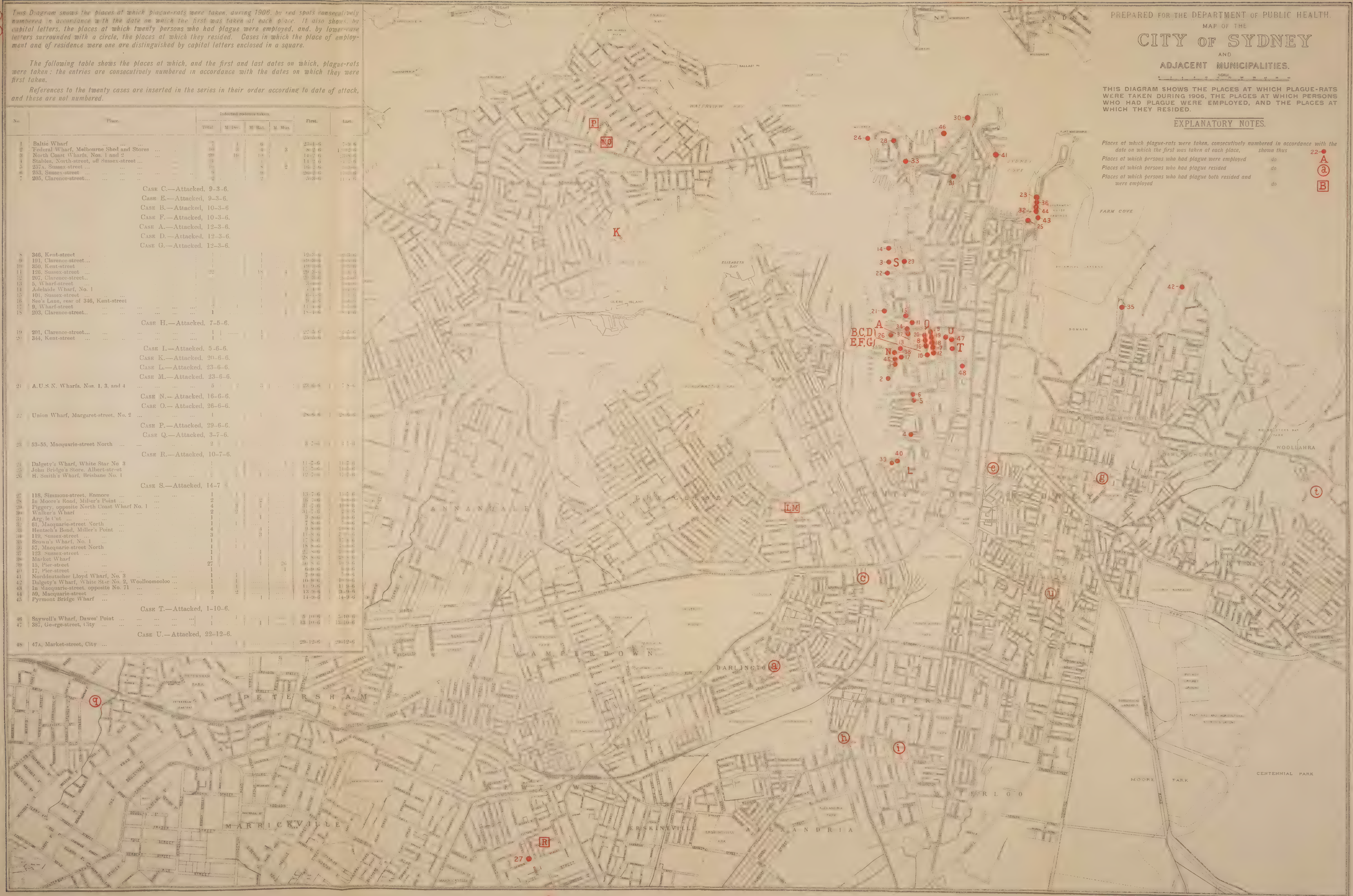
or business places within the Darling Harbour area. Down to the end of June all were taken on premises so situated; but at beginning of July some were found at the northern end of Macquarie-street, inland of the eastern margin of Sydney Cove (Circular Quay). They then began to be found about Miller's Point, as well as at fresh or old points on, or in the neighbourhood of, the Darling Harbour wharf-line. The last two of the year were found in George and in Market streets; but the only plague-rat found at a distant point was that taken at 118 Simmons-street Newtown, next to the house in which Case R. occurred. No further evidence of epizoötic plague was got in that district, where one or two blocks were systematically cleansed by the local authority acting under supervision of the experienced officers of this Department, after they had been "quarantined" (to fulfil legal requirements only) by Order-in-Council made on my recommendation.

23. The methods of prevention which were employed continued to be the same as in previous years.

J. ASHBURTON THOMPSON.

[One map.]

Sydney: William Applegate Gullick, Government Printer.—1907.



This Diagram shows the places at which plague-rats were taken, during 1906, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which twenty persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the twenty cases are inserted in the series in their order according to date of attack, and these are not numbered.

No.	Place.	Infected rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
1	Baltic Wharf	7	1	6		23-1-6	7-9-6
2	Federal Wharf, Melbourne Shed and Stores	10	3	4	3	8-2-6	[illegible]
3	North Coast Wharfs, Nos. 1 and 2	29	19	10		14-2-6	23-8-6
4	Stables, North-street, off Sussex-street	1		1		14-2-6	[illegible]
5	257A, Sussex-street	10		8	2	16-2-6	[illegible]
6	253, Sussex-street	9		9		26-2-6	[illegible]
7	205, Clarence-street	2		2		5-3-6	[illegible]
	Case C.—Attacked, 9-3-6.						
	Case E.—Attacked, 9-3-6.						
	Case B.—Attacked, 10-3-6						
	Case F.—Attacked, 10-3-6.						
	Case A.—Attacked, 12-3-6.						
	Case D.—Attacked, 12-3-6.						
	Case G.—Attacked, 12-3-6.						
8	346, Kent-street	1		1		12-3-6	[illegible]
9	191, Clarence-street	1		1		19-3-6	[illegible]
10	350, Kent-street	1		1		19-3-6	[illegible]
11	126, Sussex-street	22		18	4	29-3-6	[illegible]
12	207, Clarence-street	[illegible]		1		29-3-6	[illegible]
13	5, Wharf-street	[illegible]		[illegible]		3-4-6	[illegible]
14	Adelaide Wharf, No. 1	[illegible]		[illegible]		4-4-6	[illegible]
15	101, Sussex-street	[illegible]			1	6-4-6	[illegible]
16	See's Lane, rear of 346, Kent-street	[illegible]		[illegible]		9-4-6	[illegible]
17	9, Wharf-street	2	1	1		11-4-6	[illegible]
18	203, Clarence-street	1			1	18-4-6	[illegible]
	Case H.—Attacked, 7-5-6.						
19	201, Clarence-street	1		1		22-5-6	[illegible]
20	344, Kent-street	1		1		25-5-6	[illegible]
	Case I.—Attacked, 5-6-6.						
	Case K.—Attacked, 20-6-6.						
	Case L.—Attacked, 23-6-6.						
	Case M.—Attacked, 23-6-6.						
21	A.U.S.N. Wharfs, Nos. 1, 3, and 4	5	2	3	...	23-6-6	7-8-6
	Case N.—Attacked, 16-6-6.						
	Case O.—Attacked, 26-6-6.						
22	Union Wharf, Margaret-street, No. 2	1		1		28-6-6	28-6-6
	Case P.—Attacked, 29-6-6.						
	Case Q.—Attacked, 3-7-6.						
23	53-55, Macquarie-street North	2	2			3-7-6	[illegible]
	Case R.—Attacked, 10-7-6.						
24	Dalgety's Wharf, White Star No. 3	1			1	11-7-6	11-7-6
25	John Bridge's Store, Albert-street	[illegible]	[illegible]			[illegible]	11-7-6
26	H. Smith's Wharf, Brisbane No. 1	2	1	1		12-7-6	17-7-6
	Case S.—Attacked, 14-7-6.						
27	118, Simmons-street, Enmore	1	1			13-7-6	13-7-6
28	In Moore's Road, Miller's Point	2		2		16-7-6	[illegible]
29	Piggery, opposite North Coast Wharf No. 1	4	3	1		31-7-6	[illegible]
30	Walker's Wharf	2	2			31-7-6	[illegible]
31	Argyle Cut	1		1		3-8-6	3-8-6
32	61, Macquarie-street North	1	1			7-8-6	7-8-6
33	Hentsch's Bond, Miller's Point	4		4		9-8-6	[illegible]
34	119, Sussex-street	3		3		11-8-6	[illegible]
35	Brown's Wharf, No. 1	1	1			17-8-6	17-8-6
36	57, Macquarie-street North	1	1			18-8-6	[illegible]
37	123, Sussex-street	1		1		22-8-6	[illegible]
38	Market Wharf	1		1		28-8-6	28-8-6
39	15, Pier-street	27		1	26	30-8-6	10-9-6
40	17, Pier-street	1			1	6-9-6	6-9-6
41	Norddeutscher Lloyd Wharf, No. 3	1	1			7-9-6	7-9-6
42	Dalgety's Wharf, White Star No. 2, Woolloomooloo	1	1	......	......	10-9-6	10-9-6
43	In Macquarie-street, opposite No. 71	1	1	......	......	11-9-6	11-9-6
44	59, Macquarie-street	2	2	......	......	13-9-6	26-9-6
45	Pyrmont Bridge Wharf	1	......	1	......	14-9-6	14-9-6
	Case T.—Attacked, 1-10-6.						
46	Saywell's Wharf, Dawes' Point	1	1	...	...	5-10-6	5-10-6
47	387, George-street, City	1		1	......	13-10-6	13-10-6
	Case U.—Attacked, 22-12-6.						
48	47A, Market-street, City	1	1	......	......	29-12-6	29-12-6

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1906, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place,	*shown thus*	22-●
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

W. A. Gullick, Government Printer,
Sydney, N.S.W.

1908.
(SECOND SESSION.)

Legislative Assembly.
NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

PLAGUE IN NEW SOUTH WALES, 1907.

On a Seventh Outbreak of Plague at Sydney, 1907.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of Government.

On an Outbreak of Plague at Kempsey, Macleay River, 1907.

By R. J. MILLARD, M.B., Ch.M. (Syd.), D.P.H. (Camb.),
Assistant Medical Officer of Government and Acting Microbiologist.

Printed under No. 9 Report from Printing Committee, 15 *October,* 1908.

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REPORT OF THE BOARD OF HEALTH

ON A

Seventh Outbreak of Plague at Sydney, 1907.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of Government.

21st September, 1908.

In 1906, attack occurred in the last case on 22nd December, and the last plague-rat was taken on 29th December. In the year under review attack occurred in the first case on 7th January, 1907; the first rat in which plague was identified was taken on 10th January, the last on 21st September. Attack in the last case occurred on 29th December, 1907; but plague-rats in number were discovered in connection with it, and with another which preceded it (attacked 27th December) as soon as search had proceeded sufficiently, namely, on 2nd January, 1908.

2. Forty-seven cases* occurred during 1907, of which 16 ended fatally. Five of the patients were Chinese, of whom 3 were of Chinese birth, while 2 were of Chinese parentage, but born at Sydney. Four of the 5 died, 2 of them of primary plague-pneumonia. Of the 16 fatal cases 5 were notified only after death. Three of the bodies were examined, but the other 2 had been buried before their cases were brought to light by occurrence of a third case connected with them. The fatality of the disease was thus 34 per cent. on the whole number; but if the Chinese are omitted then 28·5 per cent. on whites only.

3. The clinical forms of the disease which were presented by the 47 cases were as follows:—Bubonic, 39 (in Case 11 there was merely some fulness of the left cervical region, but no defined bubo; in Case 15 there was some fulness and tenderness in Scarpa's triangle, but no defined bubo); Septicæmic, 6: Nos. 5 (d)†, 8 (d), 14 (d), 16 (d), 22 (d), 38 (d) (in Case 5 (d) glands in the left cervical region became tumefied a few hours before death early on the fifth day); Primary plague-pneumonia, 2: Nos. 6 (d), 7 (d).

Table I.—Showing the situations in which the buboes occurred in the 39 Bubonic cases.

Left femoral chain, 14 (Nos. 1, 2, 3, 4, 9, 23, 28, 29, 30, in which two glands could be distinguished, 32, 39, 42 (d), 45, and 46).

Right femoral chain, 9 (Nos. 10, 15, in which was some fulness and tenderness in Scarpa's triangle, no defined bubo, 24 (d), 25, 33, 26, 40 (d), 41, and 44 (d).

Right inguinal chain, 6 (Nos. 12, 13, 17, 18, 19, 34).

Left inguinal chain, 4 (Nos. 21, 27, 35 (d), and 43, in which was also some enlargement of the corresponding glands on the left side).

Right femoral and inguinal, 1 (No. 20).

Left femoral and inguinal, 2 (Nos. 26 (d) and 47).

Right femoral and left cervical, 1 (No. 37, d).

Left cervical, 1 (No. 11; some fulness, no defined bubo; recovered).

Femoral, inguinal, and mesenteric (necropsy), 1 (No. 31, d).

4. In a large majority of the cases attack was so sudden that the patient could name the hour at which illness supervened on a state of ordinary health. This was quite clearly the case in 27 of them, which remained after deduction of 4 concerning which no account was forthcoming; 9 in which the onset was gradual (Nos. 2, 4, 11, 17, 19, 21, 27, 42, 44); and 7 in which suddenness could not be determined because illness was first perceived on awaking at the usual time in the morning. In these cases a rigor was often the first symptom of illness, and it was either accompanied, or immediately followed by headache, to which vertigo was often added, together

---

* The details of each of these cases will be found in Appendix A, p. 31. † (d) = died.

with nausea. Occasional vomiting often followed nausea, and, when it did so, usually passed off in 24 hours. When the attack was gradual, lassitude was sometimes the first symptom, and sometimes general pains about the body, with preference for the back or loins; sometimes there was a longish term of ill-feeling which could not be more particularly described. But in some of the cases which may be considered as having begun gradually, pain in the gland in which the primary bubo developed later was the first symptom observed, as is shown more fully below.

5. The time-relation between reaction in the gland which was afterwards the seat of the primary bubo, and the onset of constitutional symptoms, was as follows in the 32 cases, of which the required details could be learned with certainty (see Appendix B, p. 43). Pain in the gland preceded constitutional symptoms, by from one or two to several hours, in 8 instances. Pain in the gland was noticed at the same time as constitutional illness in 8 others. Pain in the gland was not observed until some hours after the constitutional symptoms had declared themselves (maximum 48 hours) in 17 cases. From analogy it seems likely that these variations are, in great measure, a matter of observation; for when a wound becomes septic in the hand of one who knows the risk, deep pressure detects tenderness in the axilla although no discomfort was felt there before search. Most likely, therefore, some reaction attended by tenderness always occurs in the gland which the inoculated virus first reaches, but is often overlooked by the patient because pain is usually not felt till a later time. Perhaps the evidence may be interpreted as follows:—The bacillus (which but seldom causes reaction at the place of inoculation), may flourish in the gland, and produce toxins which may be absorbed in important amount before any local reaction has been manifested by pain or swelling—in which case the bubo appears as a topical effect of the toxins; on the other hand, the topical effect may be prominent from the beginning, and may be marked before absorption of toxins in amount sufficient to cause constitutional illness has taken place; lastly, as appears from Case 19 (see Appendix A, as well as from Case E, Report 1906, p. 2), a well-marked topical effect may be produced, and yet may remain the only recognisable sign of infection. These observations have interest in relation to the suggestion which has been made (though on insufficient evidence) that infection commonly occurs by way of the digestive tract, and causes a constitutional illness; the bubo, as well as the other minor alterations of the lymphatic ganglia in general, being regarded as selective results of the general infection.

6. Sixty-nine cases were reported for diagnosis during the year, all of which turned out not to be cases of plague; 51 by medical men, 17 by the police, by friends, or by the patients themselves. The 51 included cases of pneumonia, enteric, septicæmia, rheumatism, diphtheria, meningitis, and cellulitis; but 31 of them presented enlarged glands in one or other region of the body, 15 of them in the femoral or inguinal chains. As a rule there was little difficulty in tracing the glandular swellings to some usual cause; but 2 of these cases were clinically indistinguishable from plague, and it was only as the result of bacteriological examination that one of them was found to be caused by a diphtheroid bacillus, the other by a Gram-positive diplococcus, and that the negative diagnosis was established. Similar experiences in former years had been nearly the same. Thus, in each of the years 1901–6 cases were reported for diagnosis in the following numbers:—11, 103, 12, 15, 34, and 23, among which the diseases mentioned above were recognized. Only 4 or 5 ambulatory cases have been met with since plague first appeared, of which two have just been cited (par. 5), and, as has been noted in the Report for a former year, we have seen nothing of *pestis minor*.

7. The total number of rats and mice destroyed during the year was—of rats, 62,012; of mice, 28,363; total, 90,375. Payment was made to the public for 42,635 rats, and for 16,119 mice, total 58,754, brought in between 13th February and 31st December; none of these were examined.

8. The number submitted by the Intelligence Staff during the whole year was, consequently, of rats 19,377, of mice 12,244, total 31,621, all of which were examined; there were also 2 water-rats (hydromys) and 3 domestic cats, of which none were infected.

9. The several species occurred in the following numbers, and proportions expressed as percentages on the whole number submitted (31,621):—*M. decumanus*, 8,628 (27·2 per cent.); *M. rattus*, 10,749 (33·9 per cent.); *M. musculus*, 12,244 (38·7 per cent.).

10. The number in which plague was identified was 219, namely—*M. decumanus*, 57; *M. rattus*, 143; *M. musculus*, 19. The percentages of infected specimens to the total of each species was ·66, 1·3, and ·15 respectively. I have already remarked that mice seem to be less susceptible than rats (Report 1904, par. 13); and that such evidence as I have been able to collect on the point goes to show that plague in the mouse is not a cause of plague in man (see Appendix G, par. 25, p. 64).

11. Table II shows the number of rats collected in twelve consecutive calendar months, the number of males and of females, and the number and percentage of pregnant females, of each species:—

TABLE II.—SYDNEY, 1907–8.

	M. decumanus.					*M. rattus.*				
	Total.	M.	F.	Pr.	Per cent.	Total.	M.	F.	Pr.	Per cent.
1908.—January	1,058	726	332	48	14·4	927	514	413	68	16·4
February	1,369	961	408	55	13·4	952	582	370	65	16·4
March	763	426	337	39	11·5	748	413	335	51	15·2
April	609	365	244	25	10·2	613	338	275	35	12·7
May	852	533	319	16	5·3	1,161	693	468	60	12·8
1907.—June	584	381	203	18	8·8	1,053	743	310	48	15·4
July	374	215	159	16	10·	490	265	225	34	15·1
August	494	279	215	34	15·8	702	437	265	54	20·3
September	422	252	170	27	15 8	639	373	266	53	19·9
October	447	273	174	37	21·2	984	612	372	91	24·4
November	587	382	205	41	20·	741	504	237	35	14·7
December	550	345	205	27	13·1	477	282	195	26	13·3

12. Broadly, the table shows that the percentage of pregnant rats fell from January to May, when the lowest percentage occurred, that it rose from May to October, when the highest percentage occurred, and that it had fallen again by December to a point a little below the level of the initial point in the preceding January. For *rattus*, that initial point was higher than for *decumanus* by 2, but the terminal point in December was lower by one; and the proportion of pregnancies in that species was much higher both in May and in October. Some minor differences in both series of percentages being neglected, it may be said that here both species bred during the whole year, that there was slightly greater activity in this direction about September and October (Spring), that *decumanus* appears to have been the more susceptible to some hindering influence which made itself felt about May and June, and, on the whole, that *rattus* showed itself more fertile than *decumanus*.

13. The premises on which infected rats and mice were found numbered 73, and may be classified as follows:—Wharves 21, bonds 4, small steamers alongside, 2, dwellings 2, shops 35, open places 9. *M. decumanus* only was found in 18 of them, *M. rattus* only in 42, *M. musculus* only in 2, and both species of rats together, in 11.

14. Past records, and that for the present year, do not afford evidence that either species usually begins to suffer before the other. In 1903 infected specimens of *M. decumanus* were taken 5 weeks, and in 1905, 8 weeks, before any infected *M. rattus* was found; in 1904 and 1906, infected *M. rattus* was found 5 weeks and 6 weeks before infected *M. decumanus*; while in 1907 the first infected rats brought in were of both species. On 6 of the 11 premises on which both species were found in 1907, infected *M. decumanus* was first found, and the intervals after which infected *M. rattus* was first found were 5, 7, 9, 19, 27, 49, and 53 days. In the 5 houses where the contrary was the case, the intervals were 1, 21, 22, 184, and 187 days. So that it does not appear from these records that there is here any other than a casual connection beween plague in the one and in the other species. As regards individual premises, many of the intervals suggest re-invasion, for all on which infected rats (or mice) were found, were at once subjected to rigorous search, cleansing, and repair. The same methods were employed by the same staff on practically the same areas in all the years just mentioned.

15. It should be noted here that *reinvasion* and *infestation* do not necessarily connote similar structural states, nor does re-invasion indicate failure of the practicable means of exclusion. In our case the rats find harbourage under

ill-constructed

ill-constructed wharves, and food on the small foreshores such wharves leave exposed. Thence they enter buildings which have been rendered insusceptible of infestation by occasionally-opened doors, and by obscure passages which have escaped notice in course of protecting all known openings by wire-netting or other means. But such incursions are of slight importance, and are to be diminished by the costly works necessary to destroy their harbourage under the wharves referred to, in which, as well as elsewhere, they live and breed (see par. 62 below).

16. It is interesting to note in this connection that similar methods, in part borrowed from the work done towards restraint of rats, have been found effectual as against rabbits. Wire-netting of paddock fences had long been adopted as the best defence of grass, and it had been supplemented by the scattering of mineral poisons. Down to a late date this was the best plan known, but it was not completely successful until systematic destruction of harbourage was added. Then it was found that runs could be kept free, at cost, it is true, of great labour at the beginning, but with little trouble in subsequent years.

17. Table III shows the numbers of the three species which were collected and examined month by month in the years 1906 and 1907 :—

TABLE III.—SYDNEY, 1906 AND 1907.

	1906.			1907.		
	D.	R.	M.	D.	R.	M.
January	782	594	773	948	1,205	983
February	1,143	769	791	1,666	1,726	1,658
March	1,409	1,362	1,485	1,308	1,108	1,811
April	570	753	1,095	719	821	1,389
May	691	470	1,094	529	803	975
June	779	851	1,180	584	1,053	848
July	547	556	1,075	374	490	908
August	473	702	986	494	702	1,092
September	594	719	1,103	422	639	709
October	559	602	601	447	984	578
November	790	616	557	587	741	891
December	938	700	738	550	477	402
	9,275	8,694	11,478	8,628	10,749	12,244
	29,447			31,621		

18. In both years the number of rats collected during February and March was much greater than in any other month. I do not know of any circumstance to account for this variation, but possibly it stands in relation to the greater percentage of pregnancies observed in the preceding October. However, the numbers collected during December and January do not point definitely in that direction.

19. The numbers of the several species taken, the numbers found to be infected, and consequently the percentages struck with them, have, in my opinion, a significance which is strictly local (even within the infected area). They show only that there the three species existed and suffered; not in what proportion to each other they existed, nor to what extent they suffered. For reasons already given (Report, 1903, pars. 13–15) they stand in primary relation to the methods of search, not to the phenomena of the epizoötic. It is their smallness alone which allows this point to emerge and to be clearly seen, for if they were greatly multiplied they would convey an impression of approximate completeness by mere size, and, consequently, would assume the aspect of fact. If they were interpreted accordingly there would be risk of error. However, when the infected specimens have been correlated with the neighbourhoods in which they were gathered they do show with more or less exactness the area over which the epizoötic extended.

20. It is especially useful and necessary to study the circumstances which surrounded the occurrence of associated cases, of which seven groups were observed during the year. The details of each group are given below. It will be seen that the circumstances differed widely. The Bank Court (9 cases) and the Standard

Hotel (7 cases) groups are instances of association by locality alone. The Campbell-street group (4 cases) exemplifies association by contact, the first and second cases having exhibited the form of primary plague-pneumonia, but the third, in which there had been intimate association with the second, the septicæmic form; the source of the infection in the fourth case is more doubtful. The Marrickville group (2 cases) is given as a further instance of transport of the infection with fodder to a distance of several miles from the infected area, and as further evidence of the indirectness of the channel by which the infection is communicated from rat to man. Lastly, the Zetland (2 cases), Chippendale (2 cases), and the Yule-street (3 cases) groups have especial interest; they should be considered in connection with Cases L and M, Report 1906, par. 14.

21. As regards the last-mentioned groups, the sources from which the secondary cases took their infection were, most probably, the primary cases, all of which had resulted from infection taken at the centre of the city. But the way in which the infection was communicated to the secondary cases must have been indirect; for while the incubation-period of plague, in my experience (and in general experience) rarely extends over 5 days, and is much more commonly limited to 3 days or less, all the secondary cases in these groups had been out of possible contact with their primaries for more than 5 days before the dates of their attack. The choice between the indirect channels of communication is limited to two; namely, deposited infection, and infection transported and communicated by the flea. As regards deposited infection, after having noted that neither infected man nor infected animal had existed on the premises since a date anterior to the dates of infection by several days, nor, as regards animals, had at any time existed, it can be said that this source is excluded by our earliest observations (Report 1900), which have been corroborated by all subsequent experience; plague does not spread by deposited infection.

22. The flea, acting as a living intermediary, alone remains. A preliminary question in relation to this channel is whether the evidence which excludes deposited infection as a cause is not of such a nature as to exclude also communication from man to man by the flea; but the conditions necessary to enable the flea to act as a carrier from man to man are not frequently fulfilled in civilised life. The disease in the rat is almost always a septicæmia, it is almost always fatal, and that animal carries many fleas as long as illness lasts. But the contrary is the case with man in this country. Usually he and his dwelling have not many fleas, and usually the disease does not assume the septicæmic form with him, or does so as a rule only for a short time before death when, most often, patients have already been removed to hospital. If, however, man be infested with fleas, if his disease do assume the septicæmic form, and if he do die at home, then fleas which bite him are likely occasionally to receive the infection from him, and, as has now been experimentally shown, can retain their power of communicating it during several days. This I inferred in 1902 must be the case (see Report on the Second Outbreak, dated 31st July, 1903, par. 300). The necessary conditions were fulfilled in these groups.

23. Two further points must be considered in connection with the infection of these secondary cases. First, as to the kinds of fleas which may have acted as intermediaries between the patients, and the likelihood that they were present in the three houses. The Plague Research Committee in India, under direction of Dr. Charles J. Martin, F.R.S., has shown (1906) that the infection is commonly communicated between the lower animals by the species *Loemopsylla cheopis* (Rothschild). This is the common rat-flea in tropical and sub-tropical climates, and in this part of Australia. But as there were very few rats on any of the premises now under consideration (it may almost be said there were none at all), it seems unlikely that this species can have been concerned. Other species, however, possess the same power. Thus, *P. irritans* (the man-flea) bites the rat, and can even live upon it as a casual parasite; and if it has fed on a septicæmic plague rat, it can communicate the infection to healthy animals.* The same has also been shown for *P. canis* and *P. felis*.† The question whether fleas which could have communicated the disease between human beings were present in these three cases may be answered in the affirmative with probability, therefore, notwithstanding assumed absence of the species *L. cheopis*. 24.

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* *Journ. of Hygiene* (1907), p. 413, Report of the Plague Research Committee (3 successful trials out of 38); and Verjbitski, *ibidem* (1908), p. 180. † Verjbitski, *ub cit.*; (the Committee failed in 27 experiments with *P. felis.*)

24. The second point is, whether, after all, the flea is the prime cause of epidemic prevalences of plague. That it is the channel of communication between the lower animals has been amply and conclusively demonstrated by the Committee and by others; but they have not shown, and, in default of direct experiments which cannot be performed, they could not show, that it is the common carrier from animal to man. My own unhesitating opinion is that the flea is also the ordinary channel of communication between animal and man, and it is deduced from observations in the field which were first published in July, 1903, in the Report on the year 1902. Those observations, I think, still constitute the best evidence that the flea is the common cause of the infection of man; and they have been so often overlooked that I venture to draw attention to them once more in this place (see Appendix E, p. 46, where paragraphs 262–70 are reprinted). Much additional evidence of the same kind has since accrued from further observation at Sydney. The original 12 cases were selected from a series of 139, which constituted the outbreak of 1902, with a meticulous care for exactness which need not now be quite so closely observed; and with that reservation 18 cases which afford testimony of the same kind can be chosen from the present much briefer series of 47 cases, to go no further.

THE BANK COURT GROUP.

25. This group was formed of the nine cases mentioned below; they occurred in persons whose sole connection with each other was resort to this locality in which they were employed; all of them dwelt each in his own house at various distances, which were, for the most part, considerable.

TABLE IV.

W.D.S.	Case	2 (D)	—Attacked	17	January,	at	80 King-street (Sargent).
V.B.	,,	10 (E)	,,	18	,,	,,	390 George-street (Sargent).
V.M.S.	,,	5 (F, d)	,,	21	,,	,,	394 George-street (Waters).
H.W.	,,	4 (G)	,,	22	,,	,,	390 George-street.
H.M.	,,	3 (I)	,,	23	,,	,,	80 King-street.
L.D.	,,	13 (K)	,,	25	,,	,,	390 George-street.
E.F.	,,	14 (L, d)	,,	26	,,	,,	96 King-street (Flegeltaub).
G.E.	,,	11 (M)	,,	27	,,	,,	390 George-street.
L.C.	,,	12 (N)	,,	27	,,	,,	390 George-street.

26. On 10th January the Local Authority for the City of Sydney submitted the carcases of 3 rats which had been found in Bank Court, King-street (see diagram), and on 15th January a fourth, in all of which plague was identified in the laboratories of this Department. Two premises which communicated at back with Bank Court by doors in their basements were at that date in occupation of Sargent as restaurants—namely 390 George-street and 80 King-street; but the latter premises were in course of being relinquished by them, and the internal fittings were being removed. H.M. (Case 3), and W.D.S. (Case 2), were employed on that work; H.M. reported that he had seen, but had not touched, 2 dead rats there about 8 days before he fell ill, that is to say, about the 15th January, and W.D.S. said that he had on that date collected and destroyed 2 dead rats; both men said also that there were very many fleas. The premises were well found and in very good order; only the large basement room with a tiled floor, which was used as a coffee-room, had a 4-feet ornamental wainscotting of wood which, after having been torn down, afforded ample evidence of past infestation with rats. On 21st January V.M.S. (Case 5) was attacked; she was a milliner's apprentice employed at Waters' premises which, though referred to as 394 George-street, were corner premises which extended along King-street, and over the archway which formed the entrance to Bank Court; they were thus brought into juxtaposition with 80 King-street, and in the room in which V.M.S. worked all day a used rat-hole was found which communicated with the adjoining premises. In the meantime the Local Authority for the City submitted rats which had been taken on neighbouring premises (but not from those next to be mentioned) which were all found to be plague-free; and on 23rd January complaint was made to them of offensive smells at 390 George-street. Sargent then, on 24th January, removed an iron ceiling and wooden casing which surrounded two girders in the basement of these premises (not used by customers), and found a number of putrid carcases—more than 12—none of which were submitted. But from patients who had

been

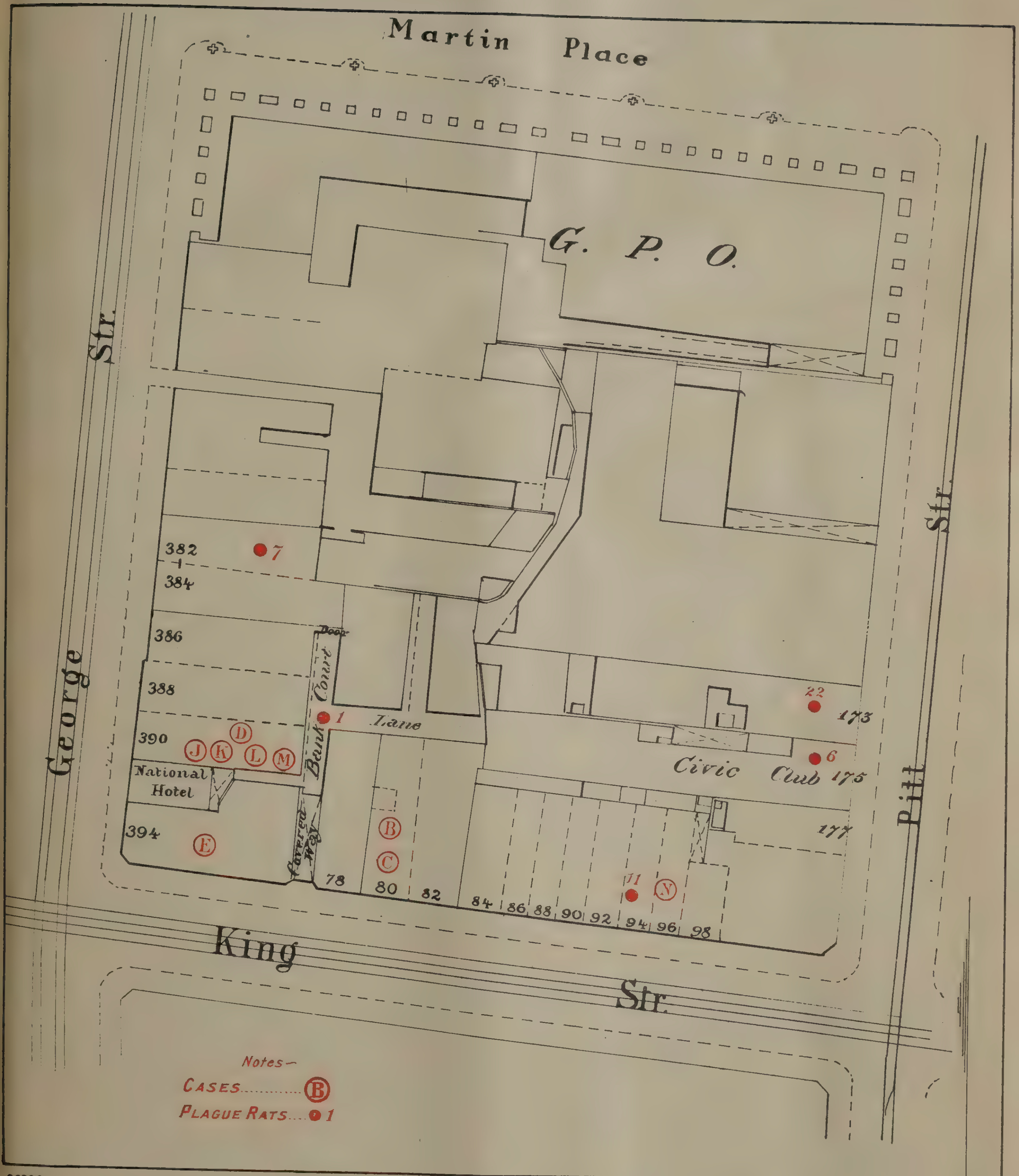

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PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

been employed on these premises statements were obtained which showed that there had been mortality among the rats infesting other parts of it; thus H.W. (Case 4), attacked 22nd January, said he had lately seen several dead rats lying about, though he had not touched them; while L.D. (Case 13), attacked 25th January, and L.C. (Case 12), attacked 27th January—waitresses—both said that many dead rats had been found recently before. The kitchen was on the top floor, and the waitresses were employed on the second and third floors. The whole of these new, extensive, and fine premises were used as a restaurant and pastrycook's shop, and were excellent in structure and maintenance; with exception of some wooden fittings they presented no faults, but the use to which they were put caused them to become invaded by rats. Possession was taken of the whole block (which included the General Post Office) though without interference with current trade, save at Sargent's—a proceeding afterwards regularised by Proclamation issued by the Executive Government. Evidence of spread of the infection to other parts of the block, in the form of infected rats, was got only in the cases of 382-4 George-street (in communication with Bank Court) and of the Civic Club, 175 Pitt-street, which opened on that court at the back; but another case, E.F., (Case 14) occurred at 96 King-street in the person of a working jeweller there employed, who was attacked 26th January. No plague-rat was found there, nor any good evidence of infestation, but the house abutted on the Civic Club at the back.

THE CAMPBELL-STREET GROUP.

27. The group was composed of the 4 cases, Nos. 6 to 9. They were connected in part clinically, and probably in part merely by locality. Campbell-street lies within the city.

28. Lock, a Chinese, carried on business as a fruit and produce merchant at 24–26 Campbell-street, Belmore Market. Chong Wing On was his foreman and buyer; he lived in Parker-street, close by Campbell-street; his business caused him to frequent the Darling Harbour wharves at which produce is chiefly landed, which were infected with plague at the dates to be mentioned. On 9th January Chong Wing On (Case 6) married a sister of Mrs. Lock, both the latter being natives but the children of Chinese parents. After the wedding he and his wife went to the suburb of Manly for their honeymoon; but he was taken ill on the way on board the ferry-steamer. He returned to Sydney on the 10th, and died at Parker-street on the 13th. Mrs. Chong Wing On (Case 7) nursed her husband; she fell ill during the evening of the 15th January, was removed to a private hospital on the 17th, and died on the 19th. Mrs. Lock (Case 8) was constantly with her sister, Mrs. Chong Wing On, during the latter's illness. She sought advice on 24th January, on the same day was removed to a private hospital, was admitted to the Coast Hospital on the 26th, and died there on the 27th of plague. She had no pulmonary affection, and no bubo (necropsy); efforts to recover the bacillus from peripheral blood taken on the 26th, as well as from heart-blood taken post-mortem, failed. After the cause of her death had been ascertained, inquiry was made of the medical men who had attended her sister and her sister's husband, and who had ascribed their deaths to pneumonia. In view of the ascertained cause of Mrs. Lock's death, they expressed the opinion that probably the disease in both cases had been primary plague-pneumonia.

29. Ma Kong (Case 9) was a labourer who probably worked for Lock, and, with other labourers in that employment, at all events lodged at 24–26 Campbell-street. Straightforward accounts of his relations with Lock could not be got; but there is very little doubt that they were as just mentioned. While in apparent good health, he became suddenly maniacal on Lock's premises on 25th January, and was admitted to the Coast Hospital on the 26th where he suffered from bubonic plague. He was discharged, well, after an illness which had lasted 70 days.

30. Campbell-street is a lengthy thoroughfare; the short part of it in which are Nos. 24–26, together with Belmore Market, which stands opposite to that part, and some neighbouring streets, including Parker-street, is the centre of the distributing produce trade (as distinguished from the other centre constituted by the Darling Harbour wharves at which produce is chiefly landed), much of which is in the hands of such Chinese merchants as remain in Sydney. It is, therefore, exposed to infection from the wharf area; but prolonged search failed to reveal any infected rodent till

9th February, when the infected carcase of a rat was brought in from stables at the rear of 42 Campbell-street (8 doors from No. 26). At a much later date the infection was identified in rats taken in Belmore Market, namely, on 17th May. The two dwellings in Parker-street and 24–26 Campbell-street were free from signs of present infestation with rats, nor were there important signs of any past infestation.

31. The three cases first mentioned above seem to have been directly connected, but it is to be noticed that the third did not suffer from primary plague-pneumonia, the form exhibited (it would appear) by the second case from which (presumably) the infection was passed on. Chong Wing On, although he lived in another house, must have been intimately associated with 24–26 Campbell-street, and must have spent much of his time there in the course of business. As regards the fourth case, the source of infection can only be conjectured. There is hardly any doubt that the patient lived in the same house with the third patient, but it is not very probable that the two were in contact. This may, nevertheless, have been the case; at the same time, his occupation was one which, as past experience has shown, exposes those who are engaged in it to special risk of contracting plague whenever the disease becomes epizoötic on rats.

ROYAL STANDARD HOTEL GROUP.

32. The group was formed of cases which were associated by locality, six of the affected persons having lived at the Royal Standard Hotel, either as lodgers, or as servants, or as members of the proprietor's family, while the seventh was constantly employed there as cook, but lodged at some little distance away. Particulars concerning them are shown in the table below, in which their cases are inserted in the order of dates of attack :—

TABLE V.

—	—	—	—	—	Attacked.	Notified.	Isolated.	Discharged.	Died.	Clinical Form.
19	J.F. ...	M	18	Gen. useful ...	9 Feb...	12 Feb...	17 Feb...	26 Mar...	......	Bubonic.
18	I.R.I...	F	37	Lodger ...	10 „ ...	12 „ ...	12 „ ...	6 „ ...	......	„
22	G.B....	M	55	Servant ...	12 „ ...	13 „ ...	13 „ ...	......	21 Feb...	Septicæmic.
21	V.I. ...	F	8	Lodger ...	13 „ ...	14 „ ...	14 „ ...	6 „ ...	......	Bubonic.
23	E F....	F	24	Barmaid ...	14 „ ...	15 „ ...	15 „ ...	27 Feb...	......	„
25	H.J....	M	36	Barman ...	18 „ ...	16 „ ...	18 „ ...	21 Mar...	......	„
26	G.L....	M	47	Cook ...	15 „ ...	19 „ ...	19 „ ...	......	21 Feb...	„

33. Attention was first drawn to these cases on 12th February, when those of J.F. and of I.R.I. were notified; on which date also G.B. was attacked, but not until 11·30 p.m. It will be noticed that J.F. was not removed for 5 days. This resulted from the extremely slight signs of illness he presented (for he had at no time any constitutional symptoms), and to the negative result of direct and cultural examination of the inguinal swelling he presented; consequently the nature of his case remained obscure until an inoculated guinea-pig had died of plague on the 17th February. But it will also be noted that his infection must have been quite independent of that of I.R.I., since the latter fell ill only about 18 hours after the onset in his case. Secondly, the hours of attack in the first three cases having been about 4 p.m. on the 9th, 10 a.m. on the 10th, and 11·30 p.m. on the 12th, it must be inferred, from the incubation period of this disease, that all three were most probably infected from a common source; besides which, it is an observational fact that the disease is not, and it may safely be added cannot be, communicated from such a case as J.F.'s to others, save by inoculation done under experimental conditions. It may be taken that the first five persons were infected before the 12th; and further, that had the most effectual method of protection been used on that date, namely, evacuation of the premises by the rest of the household, attack of H.J. on the 16th might or might not have been avoided. But G.L. would certainly not have suffered had he left the premises on the 12th, and kept away from them.

31.

34. The hotel was an old brick house, which contained 28 rooms; its outside was not imposing, but still had the advantage over its internal state. It had a basement. It stood at the south-west corner of the intersection of Castlereagh and Bathurst streets, within the city, and in the immediate neighbourhood of several places from which plague-rats had been collected recently; and one plague-rat had been brought in from the hotel itself on 30th January. This infected carcase was submitted by the rat staff maintained by the local authority for the city, and was the 27th carcase taken by it on these premises on and after the 15th January, the other 26 having been examined in the Board's laboratories as usual, and found to be free from plague. The Local Authority was informed as soon as the disease had been identified, and the Medical Officer of Health for the Metropolitan District (Dr. W. G. Armstrong), in his titular capacity of City Health Officer, took the premises in hand; for the inspection, rat-proofing, repair, and disinfection of infected and of unsafe premises, within the city of Sydney only, is a part of his duty in the latter of the two capacities just mentioned. Plague was identified in 3 more carcases delivered at the Board's laboratories on the 31st January, and on 1st February the premises were taken in hand by the city staff under Dr. Armstrong's direction. Four carcases, in which plague was afterwards identified, were then turned out, the ground-floor and basement were treated with a 2 per cent. solution of formalin (used in error by the foreman), the basement was painted with petroleum waste, and legal notice was served on the owner to effect certain structural alterations and to effectually stop rat-holes. This work was begun on the 2nd February; on that date, also, the licensee removed accumulations of rubbish and lumber, and on the 8th was fined for having them on his premises. On 12th February (the day on which the first of the seven cases was notified) the whole house was treated with 2 per cent. formalin solution (used again in error); on the 14th reinspection detected some fresh rat-holes, which were filled up; and on 16th February the whole premises were disinfected with a 5 per cent. solution of phenol. No more rats could be found. At a somewhat later date the licensee closed and abandoned the house.

35. As above mentioned, the trapping and examination of rats on these premises began on 15th January. Between that date and 14th February, 52 rats and 10 mice were collected. Among the rats there was but one *M. decumanus* (18th January), the remainder having been *M. rattus*. All the infected rats were of the latter species only; the mice were not infected. The infected rats numbered 17, and they were taken almost day by day between 30th January and 5th February; one other was observed 14th February.

36. This instance may be compared with that furnished by the Criterion Hotel (see Report, Sydney, 1902, pars. 199 to 202); and although not so striking in some of its features as that was, yet the attack of V.I., after having left the house in good health for another situated some 12 miles away in a suburb then and always quite free from suspicion of infectiveness, as well as the residence of G.L. in an uninfected part of the city, where he fell ill, are observations worth notice.

THE ZETLAND GROUP.

37. The group consisted of Cases 38 and 40, father and son, who lived in the same house on the Zetland Estate, Waterloo. This locality lay 3 miles south of the infected centre of the city, and 2 miles south of the nearest point at which a plague-rat had been, or was afterwards, taken.

38. W.G., m., æt. 68, married, bricklayer (Case 38), was suddenly attacked while at work on 22nd March, towards 5 p.m., with vomiting and headache. He went home, and laid there till he died on 28th March. His body was removed to a public dead-house, and on the 29th was examined. Some glands were slightly enlarged, but were apparently normal on section, and there was no bubo; there were punctiform hæmorrhages generally distributed among the internal organs of the body; films, cultures, and inoculations done with material from a swollen gland, and from the spleen and liver, all proved positive. The body was removed from the dead-house to the place of burial direct.

39. W.G.'s movements before attack were traced with considerable exactness During the days from 4th to 16th March, he had worked at a shop which was being reconstructed, and which stood in King-street, a few doors above an hotel where it was thought M.L. (Case 35) received his infection about 14th March. This hotel was badly infested, though plague was not identified in any rat taken in it; but on 4th March a plague-rat had been taken at the shop next to that on which W.G. was at work. He had afterwards worked at, or frequented, some other places in the infected centre of the city and, in short, the origin of his infection in locality was sufficiently probable. He lived on the Zetland Estate in a one-storey brick cottage of six rooms, which was in a good sanitary state; it presented no signs of infestation, although one *M. decumanus* was taken there in the yard, as well as three mice within the house, all of which were free from infection; nor did a prolonged search of the neighbourhood either reveal many rats, or raise any suspicion of plague among them. The cottage was disinfected by the Departmental staff on 29th March. These points have importance in relation to occurrence of the following case in deceased's son, who lived in the same cottage with him.

40. F.D.G., m., æt. 26, single, plumber (Case 40), while in his ordinary good health, was suddenly attacked at 7 p.m., 8th April. On leaving the tea-table, after having eaten as usual, he staggered and had to be assisted to bed; pains in the head and back with feverishness and a sleepless night followed; at mid-day on the 9th he lapsed into unconciousness, from which he recovered after a few hours, and he died on 15th April, after an illness which had lasted seven days. Films prepared from the right inguinal bubo he presented were negative; cultures positive. His body carried many marks of old flea-bites.

41. F.D.G. had been out of work until the day of his attack, when he first had some employment at an iron-foundry which was not infected. He attended his father's funeral on 30th March, and thereafter occupied himself in assisting to trace his father's movements. This caused him to spend his time in the infected centre of the city for the most part, and it may be supposed that he ran more or less into the same danger as his father, since he made minute inquiries at all the latter's places of resort; but his attack cannot thus be satisfactorily accounted for, because his presence in the places referred to was temporary and brief, and because none of all those employed at them suffered after his father. The last occasion on which he could have had contact with his father was ten days before his attack, and, consequently, seven days, or possibly five days before he received the infection. One other person (F.D.G.'s mother) lived in the cottage; she remained well. In this instance, then, as in the cases of the Yule-street, and of the Chippendale groups (see below), it has to be pointed out that in the primary case the disease had the septicæmic form, and proved fatal at the patient's home. These are the circumstances in which fleas may receive the infection from man.

THE CHIPPENDALE GROUP.

42. This group consists of the two cases, Nos. 31 and 36, which occurred in one house; but a third, which occurred in another house near by, must be mentioned in connection with it.

43. S.C.D., f., æt. 16, single, confectioner's packer (Case 31) lived with her mother and the forewoman of the room in which she worked at the factory, at 6 Queen-street, Chippendale, a district within the city, but outside the area of known infection. She was suddenly attacked while asleep about 1 a.m. on the morning of 4th March; she was awoke by a rigor, soon became unconscious, and remained so for 12 hours. She died 7th March, after having been ill 72 hours. Her medical attendant having declined to certify to the cause of death, her body was removed on the same day to a public dead-house by order of the Coroner, and in course of the post-mortem examination signs were observed which led to report of the case as one of probable plague. Mesenteric, femoral, inguinal, and other glands were enlarged and exhibited minute hæmorrhages, but there was no bubo; films and cultures made from the liver, the spleen, and the glands mentioned proved positive. Her body was taken direct from the dead-house to the place of burial. The house was disinfected by the Local Authority for the City, under direction of the Medical Officer of Health, on the 8th March.

44. E.L.D., f., æt. 46, widow, household duties (Case 36), was S.C.D.'s mother, and continued to live in the same house, after her daughter's death. She said she had not been away from her street since burying her daughter, except to a neighbouring church five days before her attack. She fell ill suddenly, 16th March, about 3 p.m.; after moving a heavy weight she felt pain in the right groin, and found a lump in it; shortly afterwards she began to shiver, and had feelings of weakness. She was discharged from hospital after an illness which had lasted 26 days. Form, bubonic; films prepared from the right inguinal bubo were negative, but culture and inoculation yielded positive results.

45. The origin of S.C.D.'s infection was not discovered. She was employed with about 120 other hands, mostly girls, at a manufacturing confectioner's in Harris-street, City. The firm had many retail shops, of which two stood well within the area on which most of the cases of this outbreak were infected, but S.C.D. had not visited any of them. Her business was to prepare emptied boxes returned from the various shops (as well as new boxes) by lining them. No other person connected with this factory fell ill; and although there was some evidence of presence of rats it was not infested, was very well kept, well-regulated as regards waste food, and protected by half-a-dozen cats. Traps had been steadily set by the proprietors for many months, but it seemed certain that only two or three rats had been caught or heard of. The patient was well looked after by her mother, returned from work with the forewoman of her room, who lodged in her house, but occasionally went out with friends known to her mother, and visited the infected area—which practically was the central part of the city—after hours. The last occasion on which the mother could have had contact with her daughter was possibly on the fourth, but more probably on the sixth, day before she received the infection which, it appears, must have been taken by her in her house.

46. T.R., m., æt. 37, single, a labourer (Case 34), lived at 9 Milford-street, Chippendale, in a house which was not more than 60 or 70 yards away from 6 Queen-street, though in another street and across a broad road. He was suddenly attacked at 7 a.m. on 16th March; the disease took the bubonic form, and its nature was established by examination of films and cultures made with liquid extracted by puncture from a right inguinal gland. He was discharged from hospital, recovered, after an illness which had lasted 19 days. He had lodged for some months at the house where he fell ill, which was kept by two old people who were the only other occupants. He was out of work and went to many different places in search of it; especially he visited a mason's yard at the foot of Druitt-street on the 13th (or 14th) of March and waited there about half-an-hour. In that locality E.W.E. (Case 39) was infected about the 4th April, and a history of dead rats having been found some days earlier at an office he frequented was got, together with two plague-rats actually collected in the office on the 6th and 10th April; and it was discovered at that time that the whole neighbourhood, consisting of wharves on Darling Harbour, stores, &c., was badly infested with rats which had suffered rather sharply from the epizoötic at a recent date. It may be assumed, therefore, that the foot of Druitt-street was already a dangerous place when T.R. visited it about three weeks earlier, and it seems probable that he got his infection there. The reason for mentioning his case in connection with the other two lies in his landlady, who remained well, having visited S.C.D. during her illness and having assisted in laying her body out after death, in the proximity of the two dwellings, and in attack of T.R. and of E.L.D. on the same day.

47. Failure to identify the source from which S.C.D. had received her infection had already led to investigation of the neighbourhood in which she lived; and when her mother and T.R. were attacked some local source of infection seemed to be indicated rather strongly, so that the search was renewed and pressed. There were some large stables in the locality, and several factories; for the rest, it was occupied by small houses, of which many were in a poor state. Nothing which pointed to plague-infection, however, could be found, and the carcases of such rats and mice as it was possible to collect were free from plague. The nearest point at which a plague-rat was at any time collected was more than three-quarters of a mile away at Campbell-street, 9th February, and at Belmore Market in that street on 17th May, and these were solitary instances.

48. Although it is necessary to mention T.R.'s case in connection with the other two I do not think that it was really related to them. His communication with the D. house was indirect, through intermediary of his landlady, whose last opportunity of acquiring the infection so as to carry it home in a mechanical way occurred four days or six days before the date on which he must have received it; while, on the other hand, he visited many places in the infected neighbourhoods during his search for work, and one of them, which was afterwards discovered to be badly infected, on a day which was either two days or three days before the date of his attack. As a matter of mere probability, choice between the two sources thus indicated is easy; further, as a matter of experience, that which theoretically might have consisted in his landlady is not recognisable as a practical source unless, indeed, she transported an infected flea which did not attack her and which was transferred to T.R.—a merely possible occurrence. The cases of the two D. patients alone, therefore, are clearly associated cases requiring comment; and here, again, it is to be noted that the primary case exemplified the septicæmic form of plague, and ended in death at the patient's home. These are circumstances in which infection of fleas takes place.

THE YULE-STREET GROUP.

49. Yule-street lies in the suburb of Petersham, 3 miles westerly from the nearest point at which a plague-rat was taken during this outbreak, in a neighbourhood which has at no time fallen under suspicion of infectiveness. Three cases occurred in two opposite houses on different sides of the street; the first case was imported, the other two were indigenous.

50. V.M.S., f., æt. 19, draper's assistant (Case 5), was one of the Bank Court group. She fell ill 21st January while at work at 394, George-street, City, at once went home to Yule-street, and died there early on the 26th. Seven or eight hours later her body was removed to a public dead-house, and the nature of her disease was established by cultural and inoculation tests subsequently carried out with material taken from various organs. There was some slight enlargement of a cervical gland or glands on the left side, but there was no bubo, and the clinical form of her illness was the septicæmic. Her body was taken from the dead-house direct to the place of burial. On the day of her death the room she had occupied, and another in which she had occasionally lain during her illness, were disinfected by the Departmental staff. Deceased's father then destroyed some clothing, &c., as a further precaution, and he emptied the rooms, which were not thereafter used by his family, and kept the windows open. The house was a one-storey, detached brick cottage of five rooms, damp, infested with fleas, but clean and in fair general order. Closure of the two rooms referred to obliged deceased's sister, aged 16, to sleep out, and she went to the O.C.'s house on the opposite side of the street, where she shared a bed with one of the two patients mentioned below, the two families being intimate. This girl, and all the other members of the S. family remained well.

51. D.O'C., f., æt. 7, school-child (Case 15), had not been away from home for ten days before attack, save to school, but had visited the S. cottage both during V.M.S.'s illness and after her death. Having gone to bed quite well she awoke with headache on the 6th February about 6 a.m., vomited at 9 a.m., during the evening had pain in the right groin, and at 11 p m. had P. 156, T. 104°. She was removed to hospital on the 7th, and was discharged well on the 29th day from attack. She exhibited fulness and tenderness in Scarpa's triangle, but no definite bubo; cultures made with liquid abstracted from the swelling by puncture on the 3rd and 13th days of illness proved negative, as also did films, cultures, and inoculations done with blood taken from the ear on the 6th day of illness. Nevertheless it was impossible to mistake the disease, and no doubt that it was plague was felt by the experienced staff in attendance on the case.

52. A.O'C., f., æt. 9, school-child, had often visited the S. cottage with her sister. On 6th February, the day of her sister's attack, she was well and went to school as usual. In school she vomited at 3·30, and was sent home; she became feverish immediately, and at 11 p.m. had a temperature of 104°. On the 7th she was but semi-conscious, was removed to hospital, and died there on the 8th, after an illness which had lasted 56 hours. Films, cultures, and inoculation done with blood from the left ear taken on 8th February proved positive; there was no bubo, and the clinical form of the disease was the septicæmic.

53. These two children lived nearly opposite to the S. family in a semi-detached brick cottage in Yule-street, which had one storey and an attic-room; it was a poor property, but in fair general order. In both cottages there were the parents and several other children besides those mentioned; in neither family did any other person fall ill. The O'C. children who were attacked were in and out of the S. cottage during V.M.S.'s illness, and after her death; it could not be ascertained whether they entered the rooms she had occupied, but it was thought by the S. family that most likely they did not. It was not ascertained with which of the O'C. patients V.M.S.'s sister slept. The O'C. cottage was not infested with fleas. The school was quite free from suspicion of infection. As regards rats, there were none at the S. cottage, and at the O'C. cottage one old rat-hole alone furnished evidence of their past presence. Inquiry showed that there were practically no rats in the immediate neighbourhood, which was almost entirely occupied by small cottages, and none could be collected for examination. Nothing which pointed to, or aroused suspicion of, infection was subsequently at any time detected over a wide area which surrounded the centre formed by these two households.

54. V.M.S.'s body was removed from her house, where she had lain ill and died, on the day of her death; the last date on which the two O'C. children could have been in contact with it was midday on 26th January. Her room and effects were disinfected the same day. The children were suddenly attacked 11 days later; they were not infected directly from her, therefore. But during this interval they (*a*) were in contact at night at least with deceased's sister (who remained well beyond doubt), and (*b*) entered her house, and may even have entered her disinfected sick room, though on this point there is no evidence. Deposited infection might possibly have been encountered by them at the S. house at a date within the incubation period of plague, or, consequently, might possibly have been carried thence to them by deceased's sister. But, as has been remarked above, spread of the infection in those ways, if it took place, would constitute an exception to all preceding experience at Sydney, which has shown that the infection has not been so disseminated. The only explanation which carries with it any probability supported by experience arises out of the two following facts:—V.M.S. died of plague in the septicæmic form, and the cottage in which she lived, and which the O'C. children entered after her death more or less frequently, was badly infested with fleas. Unless the infection were preserved in the bodies of some of those insects, it is very difficult to see how the two children could otherwise have been so infected as to fall ill almost simultaneously, or, indeed, have been infected at all.

The Marrickville Outbreak.

55. This outbreak consisted in 2 cases only (Nos. 46 and 47), both of which were separated from Case 45 by an interval of about seven months; they represent the beginning of the subsequent "season," therefore.

56. E.K.W. (Case 46), f., æt. 21, single, was attacked 27th December. She stitched flour-bags at Joyce Bros. & Co., corner of Hay and Lackey Streets, Darling Harbour, and lived at 35, Thomas-street, in the suburb of Marrickville, some 3½ miles away. Her place of employment was newly built, very well kept, and, after inspection, was considered to offer no ground for suspicion of infectiveness. Some rats were caught which were free from infection, but there was no infestation; no plague-rat had been taken in the neighbourhood for many months, and none from the Darling Harbour wharf-line since the 21st October. Her residence, a good brick cottage, semi-detached, in good order, was found to be free from signs of infestation by rats. It stood about 70 feet from Asprey's corner produce store, 156, New Canterbury-road, and on the same side of Thomas-street, where a large business was carried on; besides the shop there were three store-rooms, each of which measured 50 feet x 30 feet. Rumours of dead rats and offensive smells at this store were heard, and on searching it many carcases of rats and mice, and many live rats were taken, but only in the storeroom known as No. 3; in several carcases the infection of plague was identified. It was ascertained that Asprey got his supplies in part from the country, in which case they were carted direct from a

neighbouring suburban station, but in part, also, from Howard Smith & Co.'s wharf at Darling Harbour. No direct connection between E.K.W. and this store was made out; but it was learned that she was in the habit of standing for some minutes on the pavement outside No. 3 store while taking leave of her friends after evening walks. During search of the neighbourhood, plague-infected carcases were also found at 34, West-street, and at 95 and 103, New Canterbury-road, all of them near Asprey's; and ultimately it appeared that spread of the infection had been limited to the small area thus indicated.

57. No other cases occurred in Marrickville, or in the adjoining borough of Petersham in which the last-mentioned infected houses stood, but on 29th December, J.H.K. (Case 47) was attacked in the borough of Hurstville, which lies a still longer distance from the city than Marrickville. The patient was a young man who kept five cows, and supplied their milk to his own customers. The neighbourhood in which he traded was, and continued to be, free from suspicion of infectiveness, and no rats could be found either at his cottage or at other premises near it. He was fully occupied with his business, and had seldom visited the city; he had not been to Darling Harbour. But he had obtained supplies of fodder, which included one bag of chaff, from Asprey's on 24th December, and it was ascertained that these supplies were taken from Asprey's No. 3 storeroom.

58. These data, viewed as a whole, render it unnecessary to dwell on the fact that considerable quantities of jute-bags, imported from Calcutta, were habitually stored at Joyce Bros. where E.K.W. worked. Asprey's produce is known to have been infected; the source of its infection, however, is a matter of conjecture. That part which came from the country lay under no suspicion—it was not infected. The wharf from which the remainder was carted had furnished no plague-rat for a very long time; and from no part of the Darling Harbour wharf-line (of which it formed a part), nor from anywhere else, had a plague-rat been got later than 21st October. But it cannot be concluded therefrom that the wharf was actually free from infection. The difficulty there is in accurately following the progress of the epizoötic has often been mentioned in the course of this series of reports; and discovery of a plague-rat on that wharf-line on the 13th January following, as well as at other places near by in close succession, suggests that the two-months' interval was, in its latter part at least, only one of apparent freedom. In fact, the evidence of freedom is but negative; it consisted in failure of the Intelligence Staff to secure plague-rats. This seems to me a probable explanation; but it is possible that the fodder taken by Asprey from the wharf referred to may have been imported in an infected state (Brisbane), or may have lain near such imported and infected fodder in the storage-sheds at the wharf. Unfortunately, this line of inquiry was not followed up.

59. At K.'s dairy, fodder which lay about his sheds was thickly infested by fleas, which attacked the cleansing staff very freely. None of the latter suffered; and I take this opportunity of remarking that such observations made in connection with plague cases have always been recorded by me merely as matters of fact, which might or might not have stood in important relation to the patient's disease. So also the note that the drainage area of buboes presented traces of flea-bites has been frequently made, but only as a matter of fact; and, indeed, I have pointed out (4th Report, 1904, par. 27) that traces of simple punctures (that is to say, those in which no local reaction has taken place) detected at the rather late date at which patients usually first come under observation, have probably resulted from wounds inflicted after the date on which the clinical history showed that the infection must have been received.

60. In the Report for the year 1906, par. 21, an account was given of experiments on the destruction of rats by Danysz's cocco-bacillus, both in the laboratories and in the field, conducted by Dr. R. J. Millard, Acting Microbiologist to the Board. The preparations named "Azoa" and "Ratin" having afterwards become available, Dr. Millard was directed to make further experiments with them. "Azoa" admittedly contains Danysz's cocco-bacillus, put up in a dry form; "Ratin," although said to contain a bacillus independently isolated, in point of fact contains an organism which cannot be distinguished by us from Danysz's cocco-bacillus.

Further Experiments on the Destruction of Rats by "Azoa" and by "Ratin."

By R. J. Millard, M.B., Ch.M. (Syd.), D.P.H. (Camb.), Assistant Medical Officer of Government, Acting Microbiologist to the Board of Health.

AZOA RAT VIRUS.

This virus is put up in 2 oz. bottles, which contain dry pollard presumably impregnated with a broth culture of the virus.

Pure cultures obtained by plating out this material show that the organism has the following characters :—

Morphology.—A small cocco-bacillus. Actively motile. Gram negative. Tendency to bipolar staining with carbol fuchsin.

Culture.—Grows readily at 37° C. on all the ordinary media.

Agar.—A moist creamy growth. Gelatine not liquefied.

Broth.—General turbidity in 24 hours.

Potato.—A creamy growth, with some blackening of the potato.

Milk.—Slight acidity in first 24 hours, followed by alkalinity.

Indol.—Not produced.

Glucose and Mannite.—Acid and gas produced.

Lactose.—Slight acidity only.

Saccharose.—Neither acid nor gas.

Feeding and inoculation experiments gave the following results :—

I.—Feeding with the virus according to the printed instructions issued with each bottle. The virus was mixed with dry pollard in the prescribed proportion, namely, 1 bottle of virus to 1 lb. of pollard. This mixture was fed to the following animals :—

A.—*White Mice*—

No. 1,479.—11th April, fed ; 12th, food eaten ; 15th, comatose ; 16th, dead.

Post-mortem Examination.—Heart wall dark and injected. Lungs apparently normal. Costal pleura inflamed, fluid in pleural sac increased. Liver enlarged and congested. Spleen enormously enlarged, and very soft. Kidneys and suprarenals congested.

Smears.—From liver, spleen, and heart blood contained numerous Azoa cocco-bacilli.

Cultures.—Liver and heart blood gave pure culture of Azoa. Spleen, a mixed growth of this and another.

No. 1,480.—11th April, fed ; 15th, food eaten ; 16th, sick ; 17th, dead.

Post-mortem Examination.—Heart wall dark and injected. Lungs pneumonic. Costal pleura inflamed, bloodstained fluid in pleural sac. Spleen enlarged and congested. Gut distended with watery contents. Kidneys and suprarenals congested.

Smears.—From liver contained fairly numerous Azoa cocco-bacilli ; from spleen and heart blood the same, scanty.

Cultures.—Liver and spleen gave pure culture of Azoa. Heart blood a mixed culture containing Azoa.

No. 1,524.—3rd May, fed ; 13th May, dead.

Post-mortem Examination.—Liver and spleen very much enlarged and congested. Kidneys and suprarenals intensely inflamed. Intestines filled with watery contents. Hæmorrhagic infarcts in both lungs. Heart dark and injected.

Smears.—From liver, spleen, and heart-blood contained numerous Azoa bacilli.

Cultures.—Yielded pure growths of the same.

No. 1,525.—3rd May, fed ; 13th May, very sick ; 15th May, dead.

Post-mortem Examination.—Liver enlarged and congested. Necrosed patches on surface. Spleen enlarged. Kidneys and suprarenals inflamed. Intestines filled with watery contents. Lungs slightly congested. Heart dark and injected.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

B.—*Rats* (*M. rattus*)—

No. 1,486 } 11th April, fed.
No. 1,487 } 12th April, food upset ; fresh supply provided.
No. 1,488 } 18th April, no effect ; fresh supply.
No. 1,489 } 3rd May, no effect having been produced, the rats were this day killed by chloroform and examined. The organs were in each case found to be normal in appearance. Insemination of Azoa tubes with liver and spleen substance yielded no growth.

C.—*Other Animals*—

No. 1,483, pigeon ; No. 1,484, rabbit ; No. 1,485, guinea-pig—

11th April, fed.

12th April, food upset ; fresh supply, this time of corn damped with water and mixed with Azoa.

18th April, fresh feeding of the same.

3rd May, no effect having been produced, these animals were killed by chloroform and examined. The organs were in each case found normal, and cultures made from spleen, liver, and heart-blood yielded no growth.

No. 1,514, redhead ; No. 1,515, black nun—

22nd April, fed with seed mixed with Azoa virus. No ill effect produced up to 20th May.

I*b*. Feeding with Azoa culture after growth for 24 hours on the broth recommended by Dr. Danysz for the preparation of his rat virus (*i.e.*, bouillon plus the bouilli). Mixed with corn and pollard.

A.—*White Mice*—

No. 1,532.—9th May, fed ; 15th May, dead.

Post-mortem Examination.—Liver and spleen congested. Kidneys and suprarenals inflamed Lungs slightly congested. Heart dark and injected. Intestines normal.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

No. 1,533 }
No. 1,534 } 9th, May fed; 15th, May dead.

Post-mortem and Cultural findings as in case of No. 1,532.

No. 1,535.—9th May, fed; 15th May, sick; 16th May, dead.

Post mortem findings as in case of No. 1,532, with the addition of necrotic areas in the liver. Cultural results the same.

B.—*Rats (M. rattus)*—

No. 1,536 }
No. 1,537 } 9th May, fed; 5th June, no visible ill effect; 10th June, escaped and not recaptured.

No. 1,538.—9th May, fed; 21st May, dead.

Post-mortem.—No visible affection of organ.

Spleen and liver yielded pure cultures of Azoa.

No. 1,539.—9th May, fed; 21st May, dead.

Post-mortem.—No visible affection of organs. Trypanosomes in heart blood.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

C.—*Other Animals*—

No. 1,540, rabbit; No. 1,541, guinea-pig—

9th May, fed; no Azoa infection produced.

II. Feeding with infected carcases.

i. Material used.—Carcases of No. 1,479 (white mouse), infected by feeding (*vide supra*), and of No. 1,482 (guinea-pig), infected by inoculation. Both these animals died on 16th April. Two rats were thus fed with the following results:—

Nos. 1,492 and 1,493 (*Rattus*), 16th April, fed; 3rd May, no visible ill effect having appeared, both were killed by chloroform and examined; no naked-eye signs of disease were present. Cultures made from No. 1,493 were negative, but the liver and spleen of No. 1,492 yielded pure cultures of Azoa.

ii. Material used.—Carcase of No. 1,545 (white mouse), dead on 20th May of Azoa infection after inoculation.

Nos. 1,536 and 1,537 (*Rattus*)—20th May, fed; 5th June, no visible effect; 10th June, escaped and not recaptured.

iii. Material used.—Carcase of No. 1,546 (white mouse), dead on 20th May of Azoa infection after inoculation (*vide infra*).

Nos. 1,528 and 1,529 (*Rattus*)—20th May, fed; 14th June, no visible effect; killed with chloroform; post mortem; normal; cultures negative.

iv. Material used.—Carcase of No. 1,547 (*Rattus*), dead on 21st May of Azoa infection, after combined inoculation and feeding (*vide infra*).

No. 1,549 (*Rattus*)—21st May, fed; 20th June, found dead, but not of Azoa infection; cultures from organs were negative as regards Azoa.

No. 1550 (*Rattus*)—21st May, fed; 24th June, no visible effects so far; killed with chloroform and found on examination to be normal; cultures from organs were negative for Azoa.

III. Inoculation with broth emulsion of Azoa virus, made by mixing the virus with a small quantity of sterile broth.

No. 1,476 (guinea-pig)—

8th April, inoculated in right groin with ·5 c.c.

12th to 15th April, out of sorts.

18th April, well again.

3rd May, no further ill effect; killed by chloroform and examined; no signs of disease; cultures from organs negative.

No. 1,477 (*M. rattus*)—

8th April, inoculated in left groin with ·5 c.c.

3rd May, no ill-effect having appeared, was to-day killed by chloroform and examined; no signs of disease; cultures from organs negative.

IV. Inoculation with broth culture of Azoa virus after incubation at 37° C. for 48 hours.

No. 1,481 (rabbit)—

11th April, inoculated in left grain with 1 c.c.

12th to 15th April, sick.

17th April, better.

22nd April, well again.

3rd May, no further ill effect; killed by chloroform and examined; no signs of disease of internal organs; cultures from these negative; in left thigh was a small collection of pus; culture from this pus was a mixed growth; Azoa cocco-bacillus could not be isolated.

No. 1,482 (guinea-pig)—

11th April, inoculated in right groin with 1 c.c.

12th April, sick.

16th April, dead.

Post-mortem Examination.—Right inguinal glands much enlarged and inflamed, and surrounded by large amount of bloody effusion. Peritonitis. Liver and spleen greatly enlarged and congested. Kidneys congested, but not suprarenals. Heart dark and injected. Left lung had two large hæmorrhagic infarcts in the lower lobe.

Smears.—From right inguinal glands, spleen, liver, and heart-blood contained scanty Azoa cocco-bacilli.

Cultures.—Right inguinal glands, spleen, and liver yielded pure cultures of Azoa.

DIAGRAM 1.

PLAGUE REPORT, 1907.

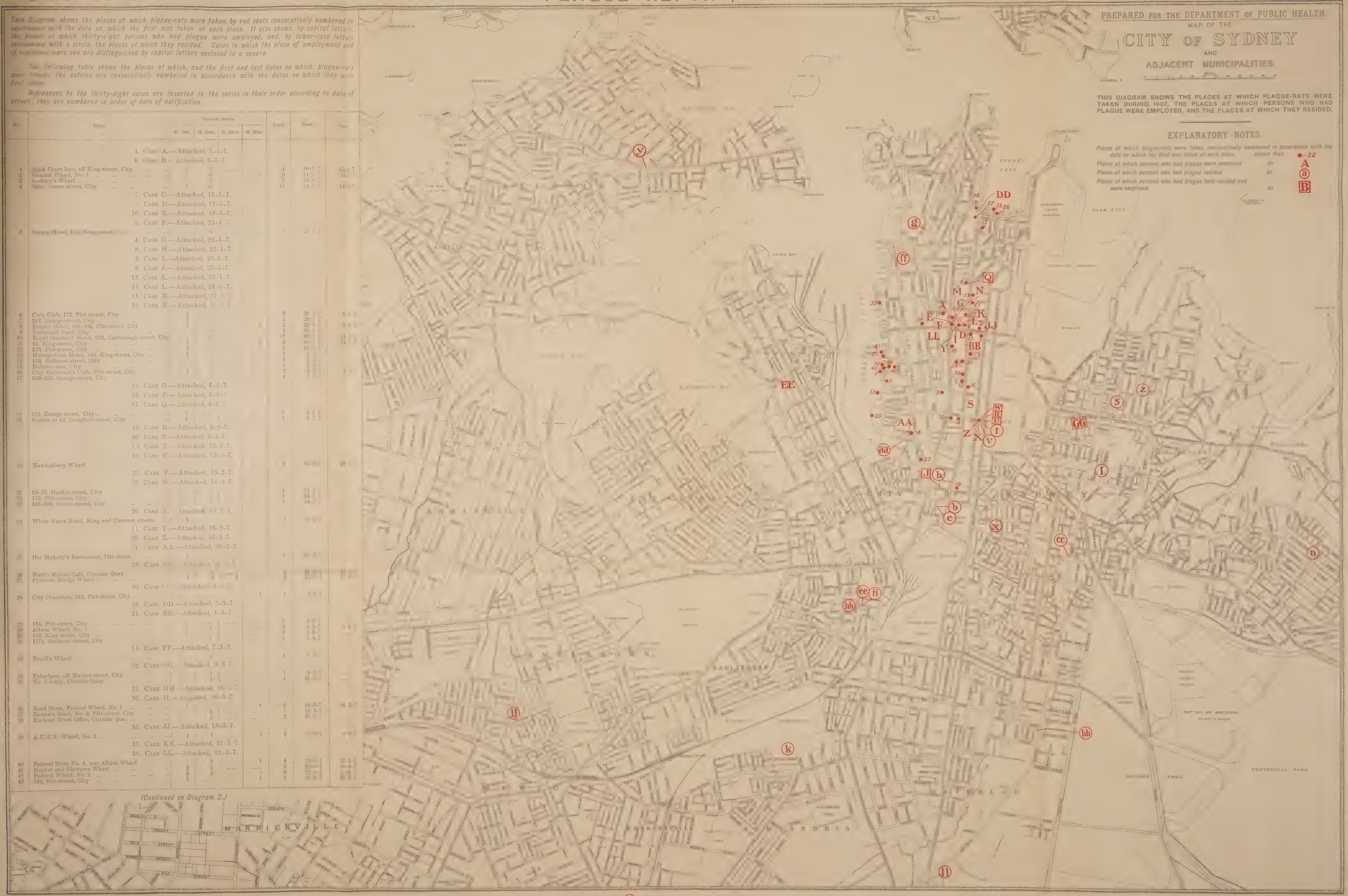
This Diagram shows the places at which plague-rats were taken, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which thirty-eight persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the thirty-eight cases are inserted in the series in their order according to date of attack: they are numbered in order of date of notification.

No.	Place.	Rodents taken.				Total.	First.	Last.
		M. Dec.	M. Ratt.	M. Alex.	M. Mus.			
	1. Case A.—Attacked, 7-1-7.							
	6. Case B.—Attacked, 9-1-7.							
1	Bank Court lane, off King-street, City	3	1	......	.....	4	10-1-7	15-1-7
2	Federal Wharf, No. 1	2	6	...	1	9	11-1-7	3-3-7
3	Lockley's Wharf		1		...	1	14-1-7	
4	345A, Sussex-street, City	1	10	...	.....	11	14-1-7	14-2-7
	7. Case C.—Attacked, 15-1-7.							
	2. Case D.—Attacked, 17-1-7.							
	10. Case E.—Attacked, 18-1-7.							
	5. Case F.—Attacked, 21-1-7.							
5	Surrey Hotel, 153, King-street, City	...	1	....	.....	1	21-1-7	.....
	4. Case G.—Attacked, 22-1-7.							
	8. Case H.—Attacked, 22-1-7.							
	3. Case I.—Attacked, 23-1-7.							
	9. Case J.—Attacked, 25-1-7.							
	13. Case K.—Attacked, 25-1-7.							
	14. Case L.—Attacked, 26-1-7.							
	11. Case M.—Attacked, 27-1-7.							
	12. Case N.—Attacked, 27-1-7.							
6	Civic Club, 175, Pitt-street, City	3				3	28-1-7	9-2-7
7	382, George-street, City...	1				1	28-1-7	
8	Empire Hotel, 101-103, Pitt-street, City	1			1	2	29-1-7	9-2-7
9	Town-hall Yard, City		1			1	30-1-7	
10	Royal Standard Hotel, 228, Castlereagh-street, City		17			17	30-1-7	14-2-7
11	94, King-street, City	4			2	6	30-1-7	14-2-7
12	279, Pitt-street, City	1				1	31-1-7	...
13	Metropolitan Hotel, 155, King-street, City ...	1				1	1-2-7	...
14	119, Bathurst-street, City		1			1	2-2-7	
15	Bulletin-lane, City		1			1	2-2-7	
16	City Tattersall's Club, Pitt-street, City	1	1	.....		2	4-2-7	5-2-7
17	349-355, George-street, City ...		1			1	5-2-7	
	15. Case O.—Attacked, 6-2-7.							
	16. Case P.—Attacked, 6-2-7.							
	17. Case Q.—Attacked, 6-2-7.							
18	412, George-street, City...	1	....			1	8-2-7	...
19	Stables at 42, Campbell-street, City ...	1				1	9-2-7	
	19. Case R.—Attacked, 9-2-7.							
	20. Case S.—Attacked, 9-2-7.							
	18. Case T.—Attacked, 10-2-7.							
	22. Case U.—Attacked, 12-2-7.							
20	Hawkesbury Wharf		2	.....	.....	2	13-2-7	20-2-7
	21. Case V.—Attacked, 13-2-7.							
	23. Case W.—Attacked, 14-2-7.							
21	53-55, Market-street, City		1		.....	1	14-2-7	...
22	173, Pitt-street, City		1		.....	1	14-2-7	
23	388-390, Sussex-street, City		1		.....	1	14-2-7	...
	26. Case X.—Attacked, 15-2-7.							
24	White Heart Hotel, King and Clarence streets ...	1		.....		1	15-2-7	...
	24. Case Y.—Attacked, 16-2-7.							
	25. Case Z.—Attacked, 16-2-7.							
	27. Case AA.—Attacked, 20-2-7.							
25	Her Majesty's Restaurant, Pitt-street ...	1			.....	1	20-2-7	.....
	28. Case BB.—Attacked, 21-2-7.							
26	Hart's Marine Café, Circular Quay		3	...	....	3	21-2-7	15-3-7
27	Pyrmont Bridge Wharf	1	3	2	.....	6	22-2-7	27-6-7
	30. Case CC.—Attacked, 1-3-7.							
28	City Chambers, 243, Pitt-street, City...				1	1	1-3-7	...
	29. Case DD.—Attacked, 3-3-7.							
	31. Case EE.—Attacked, 4-3-7.							
29	134, Pitt-street, City	1	.....	......	......	1	4-3-7	
30	Albion Wharf, No. 1 ...	1	1	......	.....	2	4-3-7	5-9-7
31	116, King-street, City ...	1	.....	......	....	1	4-3-7	....
32	117½, Bathurst-street, City		1		......	1	5-3-7	...
	33. Case FF.—Attacked, 7-3-7.							
33	Nicoll's Wharf		1	.....	.....	1	8-3-7	....
	32. Case GG.—Attacked, 9-3-7.							
34	Pyke-lane, off Market-street, City	.....	1	....	.....	1	9-3-7	....
35	No. 5 Jetty, Circular Quay	.....	1	.....	....	1	16-3-7	
	34. Case HH.—Attacked, 16-3-7.							
	36. Case II.—Attacked, 16-3-7.							
36	Bond Store, Federal Wharf, No. 1	1	......	......	1	2	18-3-7	26-3-7
37	Rowan's Bond, No. 9, Pitt-street, City	......	1	....	....	1	18-3-7	...
38	Harbour Trust Office, Circular Quay	......	2	....	......	2	19-3-7	....
	35. Case JJ.—Attacked, 18-3-7.							
39	A.U.S.N. Wharf, No. 3...	1	1	....	1	3	21-3-7	9-5-7
	37. Case KK.—Attacked, 21-3-7.							
	38. Case LL.—Attacked, 22-3-7.							
40	Federal Store No. 4, rear Albion Wharf ...	....	3	.....	1	4	22-3-7	27-3-7
41	Market and Illawarra Wharf	2	1	......	......	3	22-3-7	20-8-7
42	Federal Wharf, No. 2	6	2	....	1	9	22-3-7	5-10-7
43	132, Pitt-street, City	1	....	.....	1	2	23-3-7	28-3-7

(Continued on Diagram 2.)



PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

SCALE

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1907, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place,	*shown thus*	●—22
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

Photo-lithographed by
Gullick, Government Printer,
Sydney, N.S.W.

DIAGRAM 2.

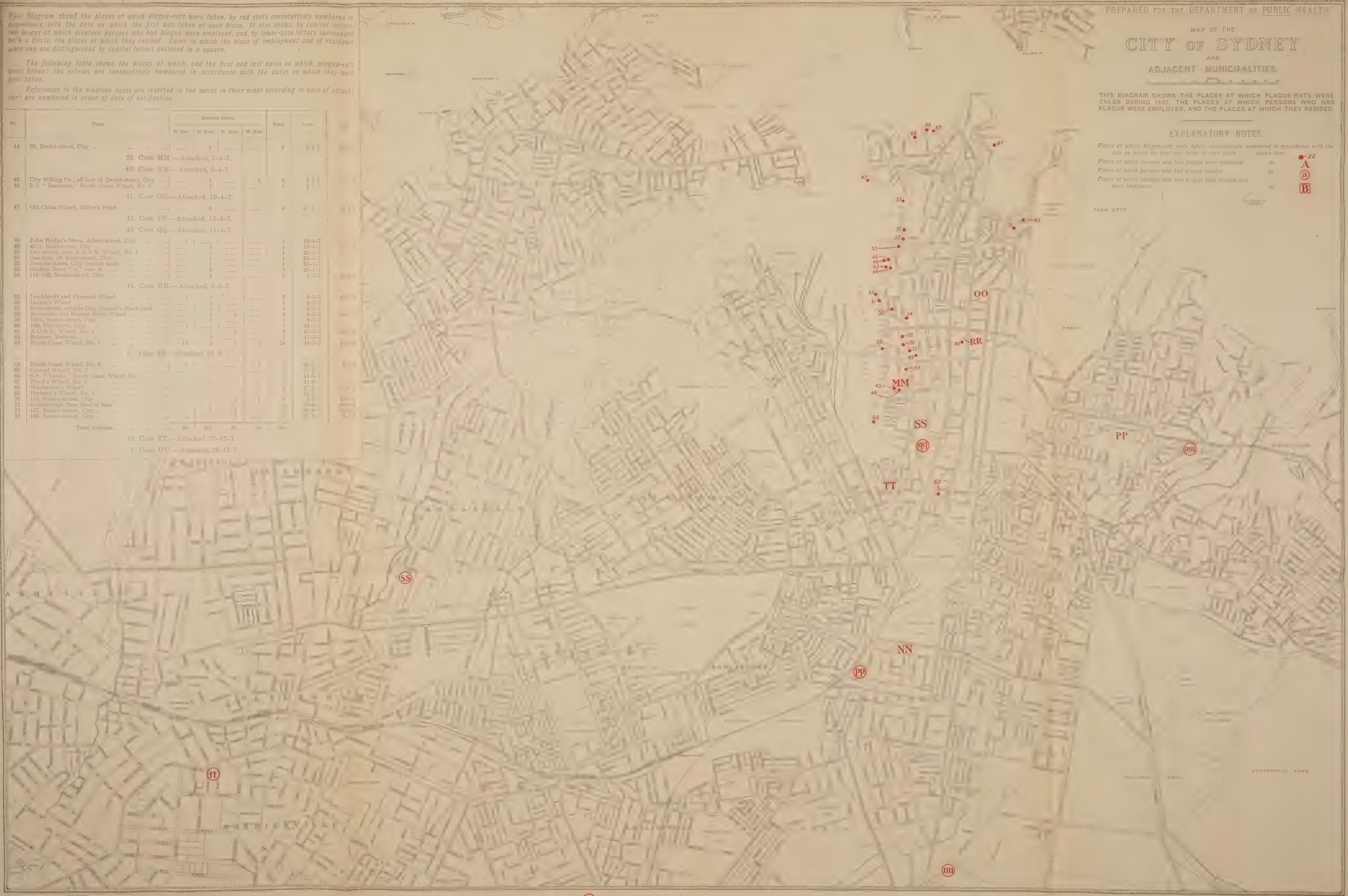
PLAGUE REPORT, 1907.

This Diagram shows the places at which plague-rats were taken, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which nineteen persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the nineteen cases are inserted in the series in their order according to date of attack; they are numbered in order of date of notification.

No.	Place.	Rodents taken.				Total	First.	Last.
		M. Dec.	M. Ratt.	M. Alex.	M. Mus.			
44	20, Druitt-street, City	......	2	......	......	2	6-4-7	[illegible]
	39. CASE MM.—Attacked, 7-4-7.							
	40. CASE NN.—Attacked, 8-4-7.							
45	City Milling Co., off foot of Druitt-street, City ...	......	1	......	2	3	9-4-7	[illegible]
46	S.S. "Ramornie," North Coast Wharf, No. 2 ...	......	1	......	......	1	9-4-7	[illegible]
	41. CASE OO.—Attacked, 10-4-7.							
47	Old China Wharf, Miller's Point	......	4	......	......	4	[illegible]	[illegible]
	42. CASE PP.—Attacked, 13-4-7.							
	43. CASE QQ.—Attacked, 14-4-7.							
48	John Bridge's Store, Albert-street, City	1	......	......	......	1	18-4-7	
49	407½, Kent-street, City	......	5	......	......	5	19-4-7	[illegible]
50	Day-street, near A.U.S.N. Wharf, No. 4 ...	......	1	......	......	1	20-4-7	
51	Gas-lane, off Kent-street, City..	......	1	......	......	1	23-4-7	
52	Jenkins-street, City (vacant land)	......	1	......	......	1	25-4-7	
53	Grafton Bond "G," rear of	......	3	......		3	25-4-7	
54	118-120, Sussex-street, City	......	5	......	......	5	1-5-7	[illegible]
	44. CASE RR.—Attacked, 5-5-7.							
55	Leichhardt and Pyrmont Wharf	1	1	......	......	2	6-5-7	[illegible]
56	Dalton's Wharf	......	1	......		1	6-5-7	
57	Kent-street, outside City Council's Block-yard ...	......	1	......	......	1	8-5-7	
58	Newcastle and Hunter River Wharf	......	1	1	......	2	9-5-7	[illegible]
59	189A, Sussex-street, City	......	1	......	......	1	9-5-7	
60	199, Pitt-street, City	1	......	......		1	14-5-7	
61	A.U.S.N. Wharf, No. 4	......	1	2	......	3	15-5-7	[illegible]
62	Belmore Markets...	......	2	......	......	2	17-5-7	
63	North Coast Wharf, No. 1	14	2	7	1	24	18-5-7	[illegible]
	[illegible]							
64	North Coast Wharf, No. 2	[illegible]	......	......	[illegible]	[illegible]	[illegible]	[illegible]
65	Central Wharf, No. 2	......	[illegible]		......	[illegible]	[illegible]	
66	S.S. "Tomki," North Coast Wharf, No.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
67	Flood's Wharf, No. 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
68	Warburton's Wharf ...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	Parbury's Wharf, No. 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
70	153, Sussex-street, City	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	Goldsbrough (late Mort's) lane	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	137, Sussex-street, City... ...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	168, Sussex-street, City... ..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total rodents...	58	107	35	[illegible]	[illegible]		
	46. CASE TT.—Attacked, 27-12-7.							
	7. CASE UU.—Attacked, 29-12-7.							



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EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place.	*shown thus*	●–22
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

No. 1,528 } (*M. rattus*)—
No. 1,529 }

6th May, inoculated in right groin with 1 c.c.
14th June, no visible effect; killed with chloroform.
Post mortem.—Normal. Cultures from organs negative.

V Inoculated with blood of infected animal.

i. With blood of No. 1,532 (white mouse), dead on 16th May of Azoa infection.
No. 1,543 (white mouse) } 16th May, inoculated.
No. 1,544 (white mouse) } 20th May, dead.

Post-mortem.—Liver and spleen enlarged and congested. Kidneys and suprarenals inflamed. Intestines filled with watery contents. Lungs congested. Heart dark and injected.

Liver, spleen, and heart blood yielded pure culture of Azoa.

ii. With blood of No. 1,533 (white mouse), dead on 16th May of Azoa infection.
No. 1,545 (white mouse) } 16th May, inoculated.
No. 1,546 (white mouse) } 20th May, dead.

Post mortem.—Same as in case of Nos. 1,543 and 1,544, except that in No. 1 546 intestinal contents were normal.

Liver, spleen, and heart blood yielded pure culture of Azoa.

SUMMARY OF LABORATORY EXPERIMENTS.

I.—Feeding with virus according to printed instructions.

Lab. No.	Animal.	Result.
1,479	White mouse ...	Dead in 5 days. Azoa isolated from organs.
1,480	" ...	" 6 " " "
1,524	" ...	" 10 " " "
1,525	" ...	" 12 " " "
1,486 to 1,489	4 *M. rattus* ...	No infection after 22 days. Cultures negative.
1,483	Pigeon	" " "
1,484	Rabbit	
1,485	Guinea pig... ...	
1,514	Redhead	No effect after 28 days.
1,515	Black nun ...	" "
	Feeding with Azoa culture grown on Dr. Danysz broth.	
1,532	White mouse ...	Dead in 6 days. Azoa isolated from organs.
1,533	" ...	" " "
1,534	" ...	" " "
1,535	" ...	Dead in 7 days
1,536	*M. rattus*	No visible effect in 30 days; then escaped.
1,537	"	
1,538	"	Dead in 12 days. Azoa isolated from organs.
1,539	"	
1,540	Rabbit	No infection produced.
1,541	Guinea-pig ...	
	II.—Feeding with infected carcases.	
1,492	*M. rattus*	No visible effect after 17 days. Killed with chloroform. Azoa isolated from organs.
1,493	"	
1,536	"	No visible effect after 20 days. Then escaped.
1,537	"	
1,528	"	No visible effect after 25 days. Killed with chloroform Cultures from organs negative.
1,529	"	
1,549	"	Died in 30 days. No Azoa infection.
1,550	"	Killed after 34 days. No Azoa infection.
	III.—Inoculation with broth emulsion of Azoa.	
1,476	Guinea-pig... ...	Killed after 25 days. No infection.
1,477	*M. rattus*	" " "
	IV.—Inoculation with broth culture of Azoa.	
1,481	Rabbit	Killed after 22 days. No infection.
1,482	Guinea-pig... ...	Dead in 5 days. Azoa isolated from organs.
1,528	*M. rattus*	Killed after 39 days. No infection.
1,529	"	" " "
	V.—Inoculation with blood of infected animal	
1,543	White mouse ...	Dead in 4 days. Azoa isolated from organs.
1,544	" ...	" " "
1,545	" ...	" " "
1,546	" ...	" " "

EXPERIMENT ON SHIP "HARTFIELD."

A practical trial on a large scale was made on board the ship "Hartfield," 1,815 tons, lying at Gibbs' Wharf, Darling Harbour. The ship had recently arrived in port, with general cargo, and was ascertained to be badly infested with rats. The distribution of baits, and observation as to number taken, were entrusted to one of the experienced rat-catchers employed by the Department (Adams).

For each day's distribution three bottles of Azoa were used, mixed with 3 lb. of oatmeal. To this sufficient water was added to make a thick mash, which was then put up in small paper twists.

The following table shows the number and distribution of the baits each day, and the number found next morning to have been taken :—

	13th May.		14th May.		15th May.		16th May.		Total.	
	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.
Sail-room	40	40	30	30	30	30	30	30	130	130
Main hold	147	147	...	...	...	...	...	...	147	147
Lamp-room	...	...	5	5	6	6	6	6	17	17
'Tween decks	...	...	69	69	60	60	60	60	189	189
Lazarette	...	...	20	20	20	20	30	30	70	70
Lower hold	...	...	60	60	60	60	62	62	182	182
Chain-locker	...	...	...	...	20	20	20	20	40	40
Cook's galley	...	...	...	...	...	...	6	6	6	6
Carpenter's room	...	...	...	...	...	...	6	...	6	4
Total	187	187	184	184	196	196	220	218	787	785

The ship was kept under daily observation by the rat-catcher, to ascertain the occurrence of any mortality or sickness among the rats, and to obtain any sick or dead rats for laboratory examination. The reports of the ship's company were that the rats were less noticeable, *e.g.*, made less noise a few days after the distribution of baits had been begun, but no dead or sick rats were then reported.

Two weeks after the first distribution of baits, *i.e.*, on 27th May, when it was reasonable to suppose that the virus had been well disseminated throughout the ship, I caused the rat-catcher to obtain live rats by means of cage-traps, and to bring these to the laboratory to be kept under observation. In all, 98 rats were thus obtained in the five days, 27th May to 31st May. Some of these appeared sickly on receipt at the laboratory, but this was apparently due in part, at least, to starvation, for they were very thin, and soon recovered when placed in a large cage and suitably fed. Of the total 98, 3 died on 3rd, 5th, and 11th June respectively. In none of these 3 could Azoa infection be demonstrated. The remaining 95 continued in good health and condition during a prolonged period of observation extending over some two months.

During the period 27th May to 31st May, however, the rat-catcher found in all 24 dead rats on the ship. Examination of these showed Azoa infection in 14, 5 were putrid, and in 5 others no evidence of infection was obtained.

On 2nd June the ship, having discharged her cargo and being about to load coal, was fumigated, while empty, with sulphur, with the object of killing the remainder of the rats. On searching after fumigation, 58 freshly-dead rats were obtained. These were cut open and examined at the laboratory, and in the case of 28, *i.e.*, all those in which there was the least indication of disease, cultures were made from liver and spleen. The results of these cultures were as follows :—

Azoa pure culture...	3
Overgrown...	8
Not Azoa	6
No growth...	11
Total	28

The facts concerning this ship experiment may be summarised as follows :—

1. In the four days, 13th May to 16th May, 785 baits made from 12 bottles of Azoa were taken by the rats on the "Hartfield."
2. In the period 27th May–31st May, 24 dead rats were found on the ship, and of these, 14 were definitely infected with Azoa, 5 were putrid, and for this reason could not be diagnosed as infected or not, and 5 were not infected.
3. In the same period, 27th May–31st May, 98 live rats were obtained, which showed no evidence of infection, though kept under observation for many weeks subsequently.
4. On 2nd June there were still at least 58 live rats on board, as ascertained by fumigation, and of these 3 were definitely Azoa infected, 8 others may have been so infected, while the remaining 47 showed no sign of infection.

From these observations it would appear that although some infection of the rats was produced, no considerable epizoötic was caused thereby, and that the fatality amongst such rats as were infected was small.

On 5th and 6th September Azoa baits, to the number of 1,400, were distributed by the Departmental rat-catching staff in the several areas along the harbour front in which they set their traps. The places where baits had been laid were kept under careful observation, and it was noted that by 23rd September every one of the baits had been taken.

Up to the present date no Azoa-infected rodents have been obtained, though during the period 6th September–24th October this same rat-catching staff has obtained from these same areas 1,219 rodents, which have all been examined at the laboratory.

There has, it is true, been a slight falling off in the number of rats brought in by the staff, as shown by the figures below; but the figures for the corresponding periods of last year show that then, also, there was a similar decrease in September and October, as compared with July and August, and it is probable that the decrease this year was due to other causes than the distribution of Azoa on 5th and 6th September.

RODENTS BROUGHT IN BY RAT-CATCHING STAFF.

	1906.	1907.
4 weeks ending 1st August	1,006	796
Do 29th „	1,039	735
Do 26th September	878	708
Do 24th October	852	694

RATIN.

This virus is supplied in tins holding about 3 lb. The material is apparently boiled and mashed potato impregnated with a broth culture.

Pure cultures obtained by plating out show that the "Ratin" virus is a cocco-bacillus. Its morphological and cultural characters appear to be identical with those of the "Azoa" virus, already described.

Feeding and inoculation experiments have been performed with the following results:—

I. Feeding with virus as supplied.

N.B.—The material was readily eaten by all the animals.

No. 1,494. *White Mouse*—

17th April, fed.

19th April, dead and partially eaten by No. 1,495 (white mouse which was in the same cage).

Post-mortem Examination.—Liver and spleen enlarged and congested. Kidneys and suprarenals inflamed. Costal pleura inflamed. Heart and lungs had been eaten by No. 1,495.

Smears from liver and spleen contained scanty Ratin cocco-bacilli.

Cultures.—Liver and spleen. No Ratin isolated.

No. 1,495. *White Mouse*—

17th April, fed.

18th April, fresh supply of Ratin.

19th April, had eaten heart and lungs of No. 1,494.

3rd May, dead.

Post-mortem Examination.—Liver and spleen enlarged. Kidneys and suprarenals inflamed. Heart, dark and injected. Lungs normal. Bowels normal.

Smears.—Liver and spleen. Ratin cocco-bacillus. Heart-blood negative.

Cultures.—Liver, spleen, and heart blood. Pure culture Ratin bacillus.

Nos. 1,498 to 1,506 inclusive. 9 *M. decumanus*—

17th April, fed.

18th April, fresh supply.

22nd May, remain well. Killed to-day with chloroform, and examined. No indication of infection. Cultures negative.

II. Feeding with infected carcase.

No. 1,508. *M. rattus*—

19th April, fed with carcase of No. 1,494 (white mouse dead after feeding with Ratin virus).

22nd May, remains well. Killed to-day with chloroform. No indication of infection. Cultures negative.

III. Inoculation with broth emulsion of virus.

Nos. 1,496 and 1,497. 2 *M. decumanus*.

No. 1,507. Guinea-pig.

17th April, inoculated with 1 c.c. Rats in left groin, guinea-pig in right groin.

22nd May, remain well. Killed to-day with chloroform, and examined. No indication of infection. Cultures negative.

IV. Inoculation with broth culture of virus after incubation at 37° C. for 48 hours.

No. 1,509. Guinea-pig—

19th April, inoculated with 1 c.c. in left groin.

26th April, sick with bubo.

27th April, dead.

Post-mortem Examination.—Left inguinal glands very much enlarged and necrosed. Much infiltration of surrounding tissue. Right inguinal glands also enlarged and deeply congested. Cutaneous vessels in neighbourhood engorged. Peritonitis. Liver much enlarged and injected. Spleen enlarged, dark, and showing many small areas of necrosis (miliary speckling). Kidneys injected. Vessels of stomach wall and small intestine markedly engorged. Cæcum distended with watery contents. Both lungs engorged. Heart dark and injected.

Smears.—From L. inguinal glands, contained numerous; from liver, spleen, and heart blood, scanty Ratin cocco-bacilli.

Cultures.—L. inguinal glands, spleen and liver, yielded abundant pure cultures of Ratin. Heart blood culture, 1 colony of Ratin.

EXPERIMENT ON BARQUE "QUILPUE."

As in the case of Azoa Rat Virus, a practical trial on a large scale was made on board a vessel. The vessel chosen was the barque "Quilpue," 1,316 tons, recently arrived with general cargo, which she was discharging at Federal Wharf, No. 1. She subsequently proceeded to Newcastle to load coal. She was reported as rat-infested, and this report was confirmed by the readiness with which the Ratin baits were taken.

Before any Ratin was distributed on the barque, 21 rats were caught on board and examined, and were all found free from disease.

Baits were made according to the manufacturer's instructions, by putting up the Ratin in small paper twists, and from 9–14th May inclusive, were distributed on board as shown in the table below, daily observations being made as to the number taken.

	9th May.		10th May.		11th May.		13th May.		14th May.		Total.	
	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.
Chain-locker	10	10	10	10	10	10	10	10	10	10	50	50
Sail-room	20	20	20	20	20	15	20	20	20	20	100	95
Port W. C.	3	3	3	3	3	3	3	3	3	2	15	14
Starboard W. C. ...	3	3	3	3	3	3	3	2	3	3	15	14
Paint locker	4	4	4	4	4	4	4	4	4	4	20	20
Water tank in hold ...	...	...	20	20	20	12	20	20	20	20	80	72
Main hold	144	136	128	108	124	100	120	84	115	95	631	523
Cabin	3	3	3	3	3	1	3	2	3	0	15	9
Carpenter's room ...	...	...	6	6	6	6	6	6	6	0	24	18
Total ...	187	179	197	177	193	154	189	151	184	154	950	815

The "Quilpue" was kept under daily observation by the rat-catcher who had laid the baits, but no evidence of disease among the rats was obtained. Rats from the vessel were examined bacteriologically, as follows:—

May 10th	2
„ 16th	1
„ 20th	3 killed by dog.
„ 22nd	14 trapped.

In none of these could Ratin infection be found. On 29th May the "Quilpue" went to Newcastle, and was there fumigated with sulphur while she was empty, prior to loading with coal. The object of this fumigation was to kill such rats as were still on board. As the result of a search on 31st May, 25 freshly dead rats were found, and these were brought to the laboratory in Sydney, where bacteriological examination showed no signs of Ratin infection. Some days later 11 more dead rats were found, which were putrid, and thus unsuitable for bacteriological examination. These also had probably been killed by the sulphur fumigation.

The results of this experiment may be summed up as follows:—

1. On a rat-infested vessel 950 Ratin baits were laid, and 815 taken in the six days, 9–14th May.
2. No evidence was obtainable of the establishment of an epizoötic among the rats by this distribution of Ratin.
3. Of the 39 rats caught or killed on board on 22nd May and 31st May none showed Ratin infection.
4. As the result of fumigation on 31st May, *i.e.*, three weeks after first baits were laid and taken, 36 rats were killed, and these probably represented the entire rat population of the vessel at that date.

FIELD EXPERIMENT AT GLADESVILLE.

The Hospital for Insane, Gladesville, where a field experiment with the Danysz rat virus had been conducted by me under instructions of the Chief Medical Officer of the Government (Dr. J. Ashburton Thompson) in November, 1906 (see Report, 1906, par. 21), was by permission of the Inspector-General of the Insane utilised for a field experiment with Ratin.

The same locality as before, namely, the roadway below the piggery and the cesspits where the hospital nightsoil is deposited, was selected for the experiment, as inspection showed that rats were numerous in these places.

The baits were prepared according to manufacturer's directions, and were distributed on 31st May. In all 620 baits were laid.

Reports obtained subsequently from time to time from the Assistant Superintendent of the Hospital were uniformly negative as to dead or sick rats having been observed by the staff. Nevertheless there was apparently a considerable diminution in the rat population, and when a final survey of the place was carefully made on 2nd August, *i.e.*, two months after the distribution of baits by the rat-catcher (Allen) and myself, we found a few rats, and found, moreover, that many of the rat runs which had formerly been most in use were now overgrown with weeds or cobwebs.

RATIN NO. 2.

On 13th August there was received at the laboratory a consignment of 50 tins of "Ratin No. 2," presented by the Ratin Bacteriological Laboratory through the Agent-General for New South Wales, and despatched from London on 21st June, per R.M.S. "Moldavia."

The Agent-General in his letter on 17th May (No. 07-7022), stated that this Ratin was said to possess better keeping qualities."

The tins, which bore the date of 27th May, were found to contain bread, soaked with a brownish fluid, presumably a broth culture. Of the 50 tins 11 were "blown," and in all 50 the reaction of the contents was found to be strongly acid. Attempts to grow the Ratin cocco-bacillus failed in the case of all but 7 tins, the following being the results obtained :—

36 tins yielded no growth in broth or on Agar. Of these 4 were "blown."
7 tins yielded a growth, but not of Ratin. Of these 3 were "blown."
7 tins yielded a growth of Ratin. Of these 4 were "blown."
—
50

Experiments with this Ratin No. 2 were made on rats as follows :—

Feeding with Ratin mixed with Milk as directed.

Twelve rats (*M. rattus*) were given this food, but they showed an obstinate aversion to take it, and left it almost untouched while they gradually starved.

1 was dead on the 3rd day.
5 were dead on the 6th ,,
3 ,, ,, 7th ,,
3 were given other food on the 7th day, and forthwith recovered.

The post-mortem examinations of those rats that died gave almost uniform results. In all there was great emaciation, and from none was there obtained in either smear or culture of the organs a micro-organism at all resembling the Ratin cocco-bacillus. From these circumstances it was concluded that the rats had died of starvation.

Subcutaneous Injection.

Three rats (*M. rattus*) received a subcutaneous injection in the right groin of 1·5 c.c. broth emulsion of Ratin No. 2. No effect was produced, the rats remaining in good health and condition.

As it was evident that this consignment of Ratin No. 2 had in some way become spoiled, further experiments with it were not made.

61. In considering the causes of the *persistence* of plague at this port, I remarked long ago (Report 1904, par. 13) that there was at least no need to look to a chronic form of the disease in rats, because the sole evidence of persistence consisted in discovery of carcases of rats which had died of acute plague, and because among the large numbers of rats which have been annually examined nothing happens to have been detected which was suggestive of chronic plague. On these grounds I ascribed persistence to the intricate harbourage afforded by ill-constructed wharves on the easterly shore of Darling Harbour, and by dilapidated buildings adjacent to them; but originally, also, I had forcibly pointed out the danger which wharves in the state described entailed in connection with plague (see Report, 13th November, 1900, p. 45). It was to be expected, therefore, that attention would be instantly and earnestly turned to reformation of them; and in point of fact, the Darling Harbour Resumption Act, and the Harbour Trust for the management of the port in general which was created by it, were the direct outcome of the epidemic of 1900, and of recognition of its proximate causes as expounded in the Report just cited. But though the convictions of the Government of the day were attested by this legislation, it turned out that repeated experiences and repeated demonstrations of the same kind were needed to give them practical effect.

62. The Harbour Trust Commissioners commenced on 4th March, 1901. In their first Report (June, 1902) they announced that a beginning had been made of the business of replacing with concrete the natural or roughly-paved surfaces which, covered with wooden flooring or not, formed the ground floors or basements of most of the stores and bonds; and it may be said at once that this work proceeded regularly, and so that, although it was still in progress during the earlier half of the current year (as, for instance, at the extensive Federal stores), it may now, probably, be regarded as completed. But it was not until June, 1904, that the Commissioners were able to report that rat-proofing of the quay-faces had actually begun, and that 150 feet had been completed by application to the sheet-piling of slabs of reinforced concrete. Two years later the Commissioners gave (June, 1906) a summary account of the improvements effected in the port as a whole since the inception of the Trust, and, among many other things, mentioned rat-proofing of quay-faces to a total length of 4,000 feet. Two years later still (June, 1908) the account stood as follows: Approximate length of the water-front from the northerly face of Miller's Point to

the head of the easterly shore of Darling Harbour (see diagram), 10,450 lineal feet; length of face rat-proofed, 7,100 feet; remaining unprotected, 3,350 feet—but these 3,350 unprotected feet include 600 feet belonging to the water-front of the Australian Gaslight Company's property, which the Commissioners cannot touch, so that the unprotected length for which they are responsible was 2,750 feet. Of this, 1,380 feet are reported at the present time of writing (September, 1908) to be in course of being made rat-proof. Thus there is every hope that protection of this, the only dangerous part of the port, may be completed in the course of another year or two, and then, if the surfaces of the quays are also carefully constructed and tended, so that rats can neither break through them nor get under them from behind the rat-proof facing, it may be reasonably expected that control of epizoötic plague will become easier and more complete than it has been in the past. But by themselves these measures are insufficient; they are indispensable, but in order to prevent recurrences of plague complementary precautions of a different kind must also be taken, for nowhere does plague spontaneously originate, or spring up of itself, as an outcome of local conditions.

63. Elsewhere I have ascribed *recurrences* of plague at Sydney to re-importation of infected rats, either from foreign or from Australian infected ports.* This opinion was based in part on the length of the intervals which elapsed between the four earlier epizoötics (15, 8½, and 6½ months), and in part on failure to obtain evidence of plague in the rat during them, notwithstanding steady continuance during the latter two intervals of the methods of search, which, it seemed, always proved efficient when epizoötic plague was indeed present; and that these intervals were real, and not due to some unexplained failure of method, has been shown by the experience of later years, during which epizoötic plague has been ascertained by the same methods to have been almost continuously present at Sydney, though for most part of any year only to a small extent. But if at the close of each of the earlier outbreaks the epizoötic infection had been cleared away, as I believe was the case, then recurrence must have been due to re-importations; and it should be noted in passing that sometimes such re-importations must also have occurred during times of observed persistence when, although not distinguishable, they may well have acted in frustration of our efforts to rid Darling Harbour of the infection. Now, while importation of the infection has been observed in many different parts of the world, consequent communication of it to a clean port has never, I think, been clearly traced to any particular vessel. The reason is that either plague rats have been found and destroyed before the ship has received pratique, so that communication has been made impossible, or else they have not been found, and the fact that the infection has been communicated has become manifest only so long afterwards (in the natural and necessary course, as we now know) that the ship has already cleared outwards, and all chance of tracing it to its source has been lost. These are among the circumstances which, in earlier years, permitted dispute concerning efficiency of the rat as a diffuser of this infection over seas, as well as concerning the dangers run by clean ports which admitted vessels arriving from infected ports without any particular precautions; the argument of the party which maintained the practical unimportance of ships carrying plague-rats, or the infrequency with which ships carried such rats, having been supported by reference to records which, as we have just seen, hardly could (and certainly did not) yield clear evidence to the contrary. As testifying to the practical danger of repeated importations by ships coming foreign two instances have been exactly described in the course of this series of reports (Report, 1902, pars. 50–64, from Capetown, and Report, 1903, par. 24, from Rosario; see also Appendix G, pars. 20–1, p. 63), but both were detected in time and, consequently, the danger was not realised.

64. Secondly, as regards repeated importations from Australian ports, this is probably a much greater danger, and I have no doubt that it has taken effect more frequently. Still, the conditions of coastal trade are such that no definite instance of re-importation by that means can, even now, be described. Many of the steamers which circulate in a constant stream between southern ports and the north are not empty at Sydney except when they are laid up for overhaul; and my experience is that both searches and fumigations of laden, or of partly laden, ships prove inadequate. Evidently searches must be incomplete under those conditions; and formation of air-cushions among coals and cargo on board affords protection to rats which take refuge in them, and is a phenomenon now too well known to

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* Trans. American Medical Association, Boston, June, 1906: Address on the Epidemiology of Plague (see also J. of Hyg., VI., pp. 556–7).

need more than reference in this place. It was under these circumstances that the infection originally (1900) spread to Brisbane, Queensland, more recently to coastal ports within this State (Report, 1905; see also p. 26 below), probably to Fremantle, Western Australia, and either direct, or by way of Brisbane acting as a secondary distributing centre, to several Queensland ports, where at one time or another outbreaks have occurred during the past seven years; and from those ports, which the infection had reached by sea, it must more or less often have been returned by sea both to Sydney and to other places. The case of the coasting steamship "Innamincka" on her voyage of May, 1908, exemplifies the share which may be taken by such vessels in spreading and perpetuating plague so forcibly that, although in that instance also the danger was averted, it is given in some detail below.

65. The Adelaide Steamship Co.'s "Innamincka" runs from Melbourne, Victoria, in the south, to Cairns, Queensland, in the north, carrying general cargo and passengers; going south, her cargo consists chiefly of sugar and bananas. She calls at Sydney, New South Wales, and at Brisbane, Mackay, Townsville, Bowen, and Cairns, Queensland. She is empty only at Melbourne and at Cairns, and at these ports is fumigated for destruction of rats. On the voyage now spoken of the "Innamincka" reached Sydney 21st May, from Cairns, where she had been fumigated as usual, and sailed again for Melbourne on the 22nd. During the night of the 21st a rat-catcher of the Intelligence Staff set many traps on board, and found next morning that 18 live rats had been caught; in addition, he found one dead rat lying beside one of the cages. The live rats were kept for some time, and continued healthy, but the dead rat was found to be infected with plague. The vessel having sailed in the meantime, Melbourne was warned by telegraph. On arrival there on the afternoon of the 24th the vessel was arrested, anchored in the stream, and fumigated with her cargo aboard; the next morning hatches were opened, she was taken alongside, and discharge of cargo was begun. In the course of discharging 160 carcases were found. Having been emptied, she was placed under sulphur a second time during the afternoon of the 25th; and when hatches were again opened on the 26th, 164 more carcases were turned out. After examination a number of these carcases were declared to be plague-infected. The ship was then thought to be rid of rats. She took on 8–900 tons of cargo, and sailed for Sydney as usual on her return voyage to the north. On arrival at Sydney, 29th May, she was searched by the Intelligence Staff, under supervision of the Chief Sanitary Inspector, and 41 live rats and 22 carcases were collected. Consequently, the whole of the cargo then aboard was ordered out, and during the unloading 35 rats were killed, and 34 more carcases were found. The ship was then placed under sulphur for twelve hours, with the result of finding 509 carcases of rats, 12 of mice, and 2 rats alive, though dying. Nevertheless live rats were still heard; the reason was afterwards found to be existence of a hole of communication between a forward hold and a cross-bunker in which some rats had found protection from the fumes among the coals. It was thought necessary, therefore, to empty all the bunkers; this took 36 hours of continuous work. Then the after parts of the vessel with the engine-rooms and stokeholds were first filled with sulphur-fumes, after which a second fumigation of the forward holds commenced. After this 70 carcases were found, but no live rats, and it was at length possible to say that no rats alive or dead remained on board; on 3rd June she was released, and, after loading, pursued her voyage. Altogether 734 rats were delivered at the Board's laboratories on or after 29th May, of which about 160 were putrid; 70 of them were examined bacteriologically, being selected from the batches successively brought in, and including some of the putrid carcases; 44 of these yielded positive films, and from 4 of them positive cultures were raised; 3 inoculations were done, and all 3 guinea-pigs presented after death the appearances which are typical of inoculated plague, while from their organs pure cultures of *B. pestis* were recovered. Probably the number of plague-infected animals much exceeded that mentioned, but as soon as practical needs had been met further examination became superfluous. The species of rats was *M. rattus*, and it was observed that a large proportion of the animals were young or half-grown.

66. It was learned that the master of the "Innamincka" had been supplied with a virus for killing rats by a dealer at Brisbane. He said he received 9 tubes, and that he prepared and distributed the contents of 5 of them on 20th May. The other four were handed over by him at Melbourne, and the 2 mentioned below were kindly transmitted to this Department by direction of the Chairman of the Board of Public Health (Dr. W. Perrin Norris). It was necessary, therefore, to ascertain the nature of this virus.

Examination of a virus for destroying rats, prepared by the Pasteur Vaccine Co., Paris. By C. S. Willis, M.B., Ch.M. (Sydney), D.P.H. (Eng.), Acting Assistant Microbiologist to the Board of Health.

On 4th June two tubes of a virus prepared by the Pasteur Vaccine Company of Paris were received from the Department of Public Health, Victoria; they were a part of the supply obtained by the master of the s.s. "Innamincka" at Brisbane on the 18th or 19th of May. One of these tubes had been opened; the other had not been opened, and was still sealed with paraffine as originally sent out. Each tube contained a copious grey growth on Agar, and both gave off a putrid odour on being opened.

The original sealed tube.—The growth in this tube consisted of two varieties: (a) an actively motile bacillus; and (b) a non-motile bacillus. The morphological and cultural characters of these bacilli were as follows:—

(*a*) *The actively motile bacillus.*

Morphology.—A small oval, actively motile, Gram negative bacillus.

Cultural characters :—

On Agar	An iridiscent growth covering whole slope in a few hours.
In 1 per cent. Glucose broth	Acid and gas formed.
„ „ Mannite „	No acid or gas.
„ „ Saccharose „	Acid and gas formed.
„ „ Lactose „	No acid or gas.
„ Litmus milk	Slight acidity after 7 days, no coagulation.
„ N.R. broth	Acid, no fluorescence.
„ Broth	Turbid.
„ 1 per cent. Dulcite broth	No acid or gas formed.
On gelatine	Liquefaction after some days (3 or 4).
Indol	Quantity of indol and nitrites.

This bacillus belongs to the Proteus group.

(*b*) *The non-motile bacillus.*

Morphology: A bipolar staining bacillus (somewhat like B. pestis), non-motile, Gram doubtful, Involution forms present.

Cultural characters :—

On Agar	Small watery discrete growth very like Conn's B. acidi lactici. No density in the growth even after several days incubation.
In 1 per cent. Glucose broth	Acid formed.
„ „ Mannite „	„ „
„ „ Saccharose „	„ „
„ „ Lactose „	No acid „
„ „ Dulcite	„ „
„ Litmus milk	„ „ Milk not coagulated.
„ N.R. broth	No fluorescence.
On potato	No growth.
„ gelatine	No liquefaction.
In broth	Small flocculi.
Indol	No indol formed.

The opened tube.—This was found to contain two bacilli presenting similar morphological and cultural characters to those found in sealed tube.

Inoculation of Animals :—

I. *Guinea-pigs:*

5th June.—Guinea pig (1,955) inoculated in right groin with growth from sealed tube.
15th June.—Dead.

Post mortem.—Intestines inflamed. Liver, spleen, and kidneys normal. Congested patch in left lung. Lymphatic glands not enlarged.

Smears from heart's blood—

Liver	Nil.
Spleen	
Right inguinal glands	

Cultures from heart's blood—No growth.
„ „ liver—No growth.
„ „ spleen—Staphylococcus albus.
„ right inguinal gland B. pyocyaneus and a diplococcus Gram positive.

5th June.—Guinea-pig (1,956) inoculated in right groin with growth from opened tube.
9th June.—Found dead in yard (had escaped from cage).

Post mortem—All organs normal.
Smears from organs—Nil.
Cultures from organs—No growth.

13th June.—Guinea-pig (1,964) inoculated in right groin with broth emulsion of a culture of the actively motile (Proteus) bacilli.
2nd July.—No symptoms since inoculation. Discharged.
13th June.—Guinea-pig (1,965) inoculated in right groin with broth emulsion of a culture of the non-motile bacilli.
14th June.—24th June, 1908. Well.
25th June.—Sick.
26th June.—Dead.

Post mortem—	Spleen	Normal.
	Liver	
	Kidneys	
	Lungs	
	Heart	
	Lymphatic glands	

Intestines showed signs of muco-enteritis.

Cultures from	heart's blood	No growth.
	liver	
	spleen	

8th July.—Two guinea-pigs (1,981, 1,982) injected in right groin with 1 c.c. broth emulsion of non-motile bacillus.

18th July.—No symptoms since inoculation. Discharged.

NOTE.—Guinea-pig (1,955, 1,956, and 1,965) apparently died, not as a result of injection, but from some other cause.

II. *Rats:*

5th June.—Two rats (*rattus*) (1,957, 1,958), each injected in right groin with 0·5 c.c. broth emulsion of virus.

26th June.—No symptoms in either since inoculation. Both killed with chloroform.

Post mortem—Appearances normal in both.

Cultures from spleen and liver of both gave no growth.

13th June.—Two rats (*rattus*), (1,966 and 1,967), each injected in groin with broth emulsion of culture of non-motile bacilli.

2nd July.—No symptoms since inoculation. Discharged.

Feeding rats with virus—

11th June.—Rat (*rattus*) (1,962), fed with crushed corn (about ¼ lb.) infected with contents of sealed tube.

2nd July.—No symptoms to date. Discharged.

11th June.—Rat (*rattus*) (1,963), fed with crushed corn (about ¼ lb.) infected with contents of opened tube.

2nd July—No symptoms to date. Discharged.

One sealed tube of rat virus (Pasteur Vaccine Co., Limited) was kindly obtained from the vendor in Brisbane who had supplied the master of the "Innamincka," by direction of the Commissioner of Public Health (Dr. B. Burnet Ham) and forwarded to this laboratory; it was received 6th June. This tube contained a copious grey growth on Agar similar in appearance to the growth in the tubes received from Melbourne. It was found to contain two varieties of bacilli:—

(*a*) An actively motile bacillus forming great part of growth. The morphological and cultural characters of this bacillus were the same as the actively motile bacillius obtained from the Melbourne tubes.

(*b*) A bacillus which I was unable to isolate.

Pathogenicity.—

11th June.—Rat (*rattus*) (1,961), fed with crushed corn (about ¼ lb.) infected with contents of tube.

2nd July.—No symptoms since inoculation. Discharged.

9th July.—White mouse (1,983), injected in left groin with 0·25 c.c. broth emulsion of the contents of tube.

18th July.—No symptoms since injection. Discharged.

The bacilli both in the Melbourne and Brisbane tubes were, therefore, non-pathogenic to rats and guinea-pigs.

In all the tubes the predominating growth was due to an actively motile bacillus belonging to the proteus group. This bacillus was the cause of the putrid odour given off by the tubes when opened.

The second (non-motile) bacillus in the Melbourne tubes I was unable to name, but it was neither B. pestis nor the Danysz cocco-bacillus.

67. It is reasonable to infer from this case, in which presence of the infection was discovered almost by accident, that coastal steamers have probably been an important means of maintaining plague in the Commonwealth from year to year. Special treatment of them is needed in the general interest; and for practical purposes this would best consist in careful fumigation with sulphurous-sulphuric gases, while empty, at regular intervals. The intervals, I think, should be about six weeks, but they might be slightly extended when necessary to suit dates of arrival at terminal ports where alone the vessels could be so handled with but trifling delay. Additionally, any effectual method which may be devised of preventing interchange between ship and shore rats while lying alongside should be enjoined and enforced; but I feel obliged to add that, in my opinion, the measures hitherto taken with that object—namely, fending off, rat-guards on springs and hawsers, closure of openings next the wharf, &c., &c.—have proved of little practical value. The case of the "Innamincka" itself shows that these precautions have not been neglected in the past, and have been taken under direction of the several governments concerned; but it shows, also, that they have not been effectually taken. Nor, I think, is it likely that they will or can be effectually taken as long as they depend on the co-operation of different authorities which are unco-ordinated by any joint agreement formally recognised. However, this obstacle will soon be removed. During the current year the Parliament of the Commonwealth has passed a Quarantine Act, which will be brought into operation by proclamation as soon as the details of the service have been organised, and thus that uniformity of quarantine law and practice in Australia will come about which first began to be urged in New South Wales just twenty-five years since.*

J. ASHBURTON THOMPSON.

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* Intercolonial Sanitary Conference of Sydney, 1884: President, the Hon. Charles K. Mackellar, M.B., Medical Adviser to the Government; Secretary, J. Ashburton Thompson, M.D., D.P.H. Ordered by the Legislative Assembly to be printed, 26th November, 1884. Sydney: Thomas Richards, Government Printer.

REPORT

ON AN

Outbreak of Epizootic and Epidemic Plague at Kempsey, Macleay River, N.S.W., in 1907.

Compiled by R. J. MILLARD, M.B., D.P.H.,
Assistant Medical Officer of the Government and Acting Microbiologist,
from material supplied by Dr. Woolnough, of Kempsey, and Sanitary Inspector Lloyd (Cert. R. San. I.).

PART I.

GENERAL DESCRIPTION OF KEMPSEY.

KEMPSEY is situated on the Macleay River (Lat. 31 S.), about 200 miles north of Sydney, and about 30 miles from the sea coast. The town, which was incorporated in 1886 as a borough, having an area of 4,051 acres, is divided into East, Central, and West Kempsey. East Kempsey, on the right bank of the river, is comparatively elevated, and is occupied in the main by residences. Access is afforded by a bridge across the river. Central Kempsey, on the left bank of the river, is the business portion of the town. West Kempsey, also on the left bank of the river, is about 1 mile from Central Kempsey, and is mainly occupied by residences and farms.

Population and Dwellings.—At the Census of 1901 the population of the municipality was 2,329, and the houses 453, of which 416 were wooden, 31 of brick, and 6 of other materials. The figures in 1907 are estimated to be approximately the same. The buildings are, generally speaking, old and structurally defective, and in the lower-lying parts of the town are commonly raised from the ground to escape flood-waters.

Topography and Soil.—The town is situated on both sides of a large horseshoe bend of the river, the two banks being connected by a bridge as above stated. Except in East Kempsey, the site is almost flat and low-lying, and on this account subject to periodical flooding by the river. The soil is a rich loam. The village of Greenhills is situated about 3 miles upstream, and Frederickton and Smithtown 4 and 12 miles respectively downstream from Kempsey.

Products and Communications.—Dairy-farming, maize-growing, and timber-getting are the principal industries of the district. Communication with Sydney is maintained by the North Coast Steam Navigation Company's s.s. "Ramornie," and N. Cain's Coastal Co-operative Company's s.s. "Hastings," each making one trip to and from Sydney every five days. Other steamers of both companies make occasional trips, as required, for cargo. A local steamer, the "Olga," plies daily up and down the river carrying passengers and deck cargo between the numerous river wharves.

Sanitary Circumstances and Administration.—Very little regard has in the past been paid to sanitary matters. Cesspits abound in the town, and with very few exceptions they are mere holes in the ground, at best with slabbed walls. Nor is there any regular service for emptying them. Where closet pails are used they are of the most diverse descriptions, such as kerosene tins, oil drums, butter boxes, biscuit tins, wash-tubs, &c.; and individual householders use their own discretion as to when, where, and how they dispose of the contents. Although the municipality was included in the original proclamation under the Nuisances Prevention Act, no bylaws under this Act have been made. Many closet buildings were found to be ruinous, and minor defects were numerous. The administration of the Public Health Act also has been almost a dead letter. There was an Inspector of Nuisances at 15s. per week, but he was aged, ignorant, and inefficient.

PART II.

Plague in Man.

In all, 4 cases occurred at Kempsey, concerning whom brief clinical and epidemiological details are given below. It will be noted that the first case was that of a man who had been employed in a produce store, where, on 16th and 17th January, six or seven days before the date of his attack on 23rd January, he had assisted at the removal and destruction of 31 dead rats which were found beneath one of the floors. It is stated that rat poison had been laid at this store on 31st December; but the period that had elapsed since this date, and the number of rat carcases found, make it most probable that these rats had died of an epizoötic rather than of poison. As the carcases were destroyed without examination, this point must remain undecided. This patient had symptoms of lobar pneumonia from the onset of his illness, and developed multiple buboes five days later, a few hours before his death. Though the pneumonia in this case is said to have been lobar, and as such not of the type usually found in pneumonic plague, yet as the sputum was not bacteriologically examined, it cannot be positively stated that this was not a case of pneumonic plague with secondary buboes.

He was nursed at the residence of his sister, and by her. This sister and her daughter (Cases C and B) next became ill, on 1st February and 29th January respectively, the former with pneumonic, the latter with septicæmic plague. Here there was a double possibility that these cases may have been infected either from contact with Case A, if he did have pneumonic plague, or by frequenting the presumably infected produce store.

Cases B (Rachael Maclean) and C (Mrs. Maclean) were both removed to the Kempsey Hospital on 1st February, and there died—Mrs. Maclean on 4th February and Rachael on 12th February. In the hospital they were attended by the matron and two other nurses, and on 6th February the matron (Case D) was attacked with pneumonic plague, from which she died on 11th February. As to the last case, there seems to be no reasonable doubt that she was infected from Mrs. Maclean. It is stated that the precautions against infection prescribed by the medical attendant were not strictly observed by the matron, and that on one occasion at least Mrs. Maclean is known to have coughed into the latter's unprotected face.

The following are details of the circumstances connected with these 4 cases of plague.

Case A.—Russell, Thomas James Joseph.

Summary.—Male, æt. 31 years; single; employed in Maclean's produce store, Belgrave-street. No former attack; never inoculated; no communication with any previous case. Resided in Clyde-street. Attacked 23rd January, died 29th January, 3 a.m. Pneumonic (?) plague, with cervical and double inguinal buboes. Morphological, cultural, and inoculation tests of bubo juice positive.

Movements prior to Attack.—Had not been away from Kempsey. Was regularly employed at Maclean's produce store.

History of Illness.—Taken ill suddenly on the morning of 23rd January with rigor. Temperature 103° F., pulse 120, respiration 16. Next day respiration more rapid, and definite pneumonia at left base. After this the clinical course was that of a typical lobar pneumonia until the evening of 28th January, when he became worse, with rapid pulse, and was evidently in a very grave condition. At this time it was observed that the glands of both groins and of the right side of neck had become enlarged and very tender. At 10 p.m. temperature was 105° (it had been 103° in the morning), pulse 144, and respiration very rapid and stertorous. He died at 3 a.m. on 29th January. Throughout his illness he remained at his residence, and was nursed by Mrs. Maclean (Case C). On post-mortem examination the same morning the inguinal glands and surrounding tissues were found to be infiltrated and hæmorrhagic.

Residence.—A detached four-roomed cottage in Clyde-street, in fair repair, and in cleanly condition.

Employment.—Maclean's produce store, Belgrave-street. A one-storied wooden building, containing in all 5 rooms. From under the floors of this store, five dray-loads of rubbish were removed during cleansing operations, 2nd–6th February.

Rats at Place of Employment.—About the latter end of December, 1906, rats in considerable numbers were seen about the premises. On 31st December poison was freely laid. For the following week rats were still seen about the place, but after this no more were seen. About 14th January an offensive smell was noticed in the small store, and on that date a small portion of the flooring was raised and 1 dead rat removed from underneath. On 16th and 17th January the whole floor of the small store was removed by Maclean and the patient, and rat burrows were dug out. On this occasion 31 dead rats were found. Since then rats have not been seen or heard by the occupier. When the premises were cleansed and disinfected by the Departmental Sanitary Inspector (2nd–6th February), burrows were found beneath the floors, indicating recent rat infestation, but only 1 rat was seen. This rat was killed, and no sign of infection was found in it. At residence: When the residence was cleansed and disinfected (7th–10th February), previous rat infestation was indicated by burrows leading to the cesspit, and 3 rats were found, namely, 2 skeletons and 1 putrid carcase.

Contacts.

Contacts.—Patient, being a brother of Mrs. Maclean, lived with the Maclean family. During his whole illness he was nursed at the residence by Mrs. Maclean. Other members of the household were Mr. Maclean, Rachael, aged 11 years, and John, aged 9 years. Of these persons, Mrs. Maclean and Rachael subsequently became infected (Cases C and B).

CASE B.—MACLEAN, RACHAEL ANN.

Summary.—Female, æt. 11 years; single; school girl. No former attack; never inoculated. Resided at same address as Case A. Attacked, 29th January; died, 12th February. Septicæmic plague.

Movements prior to Attack.—Had not recently been away from the district. Was in the habit of spending a good deal of her time at her father's produce store, where her uncle, J.R. (Case A), was employed.

History of the Case.—On 29th January was taken ill with headache and nausea. When seen by Dr. Woolnough on 1st February, had temperature 103° F., pulse 130, weak and dicrotic, headache, nausea, and general malaise. She was admitted to the Kempsey Hospital the same day. On 5th February she was much worse, had a rigor, and at 11 a.m. her temperature was 105° F. Her temperature continued high, and general condition bad, until her death on 12th February. No pneumonia nor bubo developed.

Residence, Rats, and Contacts.—See Case A.

CASE C.—MACLEAN, BRIDGET ANN.

Summary.—Female, æt. 34 years; married; wife of produce merchant. No former attack; never inoculated. Resided at same premises with Cases A and B, being sister of Case A and mother of Case B. Nursed Case A throughout his illness at their residence. Attacked, 1st February, 10 a.m.; died, 4th February, 4 a.m. Pneumonic plague. Morphological, cultural, and inoculation tests (of sputum) positive.

Movements prior to Attack.—Had not been away from house; had been to produce store occasionally. Had nursed Case A in his illness.

History of Illness.—Taken ill suddenly on 1st February, at 10 a.m., with rigor and collapse; temperature, 104° F.; pulse, 136, weak and dicrotic; extremities, blue and cold. Sent at once to Kempsey Hospital. 2nd February—Temperature 104·5° F. and definite broncho pneumona. 3rd February—Pneumonia, further developed; sputum, bloodstained; pulse, 156, and intermittent. 4th February—Died at 4 a.m., after an illness of 66 hours.

Residence and Rats.—See Case A.

Contacts.—At the hospital, whither she was conveyed within about 1 hour of her attack, she was attended by Dr. Woolnough, nursed by the matron and two other nurses, and was visited by her husband. Of these persons, one (the matron) became infected (Case D).

CASE D.—GULLIFORD, MARY.

Summary.—Female, æt. 35; single; matron, Kempsey Hospital. No former attack; never inoculated. Nursed Cases B and C. Attacked, 6th February, 11 a.m.; died, 11th February, at 1 p.m.

Movements prior to Attack.—Had not been away from district.

History of Illness.—6th February—Taken suddenly ill about 11 a.m. with rigor; pain in chest; and temperature 103° F. 7th February—Well-marked pneumonia at right apex; temperature and pulse rising. These symptoms continued, her condition grew increasingly grave, and she died on 11th February, about 1 p.m.

Residence.—The patient lived in a four-roomed wooden cottage at the Kempsey Hospital, which was in good repair and cleanly kept.

Rats.—Some rat burrows were found beneath the hospital kitchen, and 1 rat was trapped there, but was found to be non-infected.

Contacts.—During her illness the patient was attended by Dr. Woolnough and two nurses, none of whom became infected.

PART III.

PLAGUE IN RATS.

Many vague statements were rife as to rats having been unusually numerous in Kempsey in the latter part of December, 1906, and the beginning of January, 1907, but no rat mortality appears to have been observed until, as above stated, Maclean found 31 dead rats beneath his produce store on 11th January.

As soon, however, as the diagnosis of Case A had directed attention to the matter, definite evidence was obtained of epizoötic plague in the Kempsey rats. On 29th January Dr. Woolnough found in his stable a dead rat, which he describes as having "liver and spleen enlarged and hæmorrhagic, bloodstained fluid in the peritoneal cavity, and injection of intestines." No bacteriological examination was made, but this description suggests strongly that the rat was plague-infected. Dr. Woolnough had recently received chaff and other horse-feed from Maclean's produce store. On 1st February, at "Tattersall's Hotel," and at O'Halloran's adjoining premises, in Belgrave-street, in the same block as Maclean's produce store, but about 150 yards nearer the river bank, 4 dead rats were found, which were subsequently proved, by cultural and inoculation tests, to be plague-infected. When these premises were dealt with by the cleansing gang (2nd–8th February) 41 dead rats were found (mostly putrid, and therefore unfit for bacteriological examination), in addition to 33 rats that were killed or trapped. On 5th February, at Barnett's "Victoria Hotel," also in Belgrave-street, and nearly opposite to "Tattersall's Hotel," 1 infected rat was found in the yard, and subsequently 3 putrid rats. On 6th February 1 infected and 2 putrid rats were found on Ramsay's premises, in Belgrave-street, about 50 yards west of Maclean's store. On 8th February, at Fern's stables in John-street, about 100 yards south of Maclean's store, 1 infected rat was found. On 10th February, at Sydenham's premises, in Belgrave-street, next door to Ramsay's, 1 infected rat was found dead. There was then an interval of seven days till the finding, on 17th and 18th February, of 4 infected and 12 putrid rats at the North Coast Steam Navigation Company's wharf on the river bank. After this no more infected rats were found.

Thus, altogether, seven premises were found to be harbouring infected rats, infection being positively demonstrated in 12 rats from these places, and on some other premises evidence was obtained of previous rat mortality.

The following table summarises the above facts, and shows the chronological relations of the occurrence of cases, and finding of infected rats:—

TABLE A.

	Infected Rodents.					Other Rodents found dead.
	Rats.	Mice.	Total.	First.	Last.	
Maclean's produce store	...	...	...	......	......	31 rats on 16–17 Jan.
Dr. Woolnough's stable	...	...	...	......	......	1 rat on 29 Jan.
Case A, attacked 23rd January.						
" B " 29th "						
" C , 1st February.						
"Tattersall's Hotel," Belgrave-street ...	3	...	3	1 Feb.	6 Feb.	41 rats, 2–8 Feb.
O'Halloran's premises (adjoining)	1	...	1	1 "	......	
"Victoria Hotel," Belgrave-street, ...	1	...	1	5 "	......	3 rats, 5 Feb.
Case D, attacked 6th February.						
Ramsay's saddler's shop, Belgrave-street ...	1	...	1	6 "	......	2 " 6 Feb.
Dr. Lancaster's yard (adjoining Ramsay's)	...	...	...	......	......	2 " 6 "
Fern's stables, Belgrave-street	1	...	1	8 "	......	1 rat, 8 "
W. Sydenham's premises, John-street ...	1	...	1	10 "	......	
N.C.S.N. Co.'s wharf	4	...	4	17 "	18 Feb.	12 rats, 17–18 Feb.

From 1st February to 5th March a systematic examination was made by Dr. Woolnough of all rats and mice obtainable in Kempsey. In the case of any in which he suspected plague infection, he made smears and cultures, and subsequently these were examined at the Board's laboratory to confirm the diagnosis. In all 514 rodents, namely, 455 rats and 59 mice, were thus examined. Of these, 331 were obtained in Central Kempsey, the rest in other parts of the municipality. The following table shows the number examined and the number found to be infected each week:—

TABLE B.

Week ending—	Examined.			Infected.	
	Rats.	Mice.	Total.	Rats.	Mice.
7 February, 1907	176	6	182	6	...
14 " "	167	46	213	2	...
21 " "	88	4	92	4	...
28 " "	19	3	22	...	...
7 March, "	3	2	5	...	...
Total	453	61	514	12	...

In regard to the epizoötic, the most noteworthy circumstance is that it appears to have been confined to a limited area in the neighbourhood of Maclean's produce store. With the exception of the N.C.S.N. Company's wharf on the river bank, not one of the places which yielded infected rats was more than 100 yards from the produce store. It is, no doubt, possible that there were infected rats which were not submitted for examination, but it is not likely that there were many, for a very thorough search was made throughout Central Kempsey. One hundred and sixty-four premises were thoroughly searched by the cleansing gangs, and, in addition, diligent inquiries were made throughout the town as to the occurrence of any rat mortality. Similar inquiries were made by the police in the district surrounding Kempsey, with uniformly negative results.

As to the source whence the infection was carried to Kempsey, there can be little doubt that it was carried from Sydney in produce or other merchandise. Maclean received frequent consignments of horse-feed from Sydney. His books showed that in the month of December, 1906, he had received 393 bags of chaff from produce merchants in Sussex-street, Sydney. Infected rats were taken at the Federal Wharf, Sydney, which is in the vicinity of the premises whence the chaff was supplied, on 19th November, 11th December, and 12th December. The finding of infected rats at the N.C.S.N. Company's Kempsey wharf on 17th and 18th February, may probably be accepted as a further indication of the path by which the infection was conveyed to Maclean's store.

PART IV.

ADMINISTRATIVE MEASURES.

Immediately on receipt of news of the positive diagnosis by Dr. Woolnough of Case A as plague, Sanitary Inspector Lloyd, of the Departmental staff, who had had much previous experience in plague work, was despatched overland to advise the Local Authority (the Municipal Council) as to the action necessary to be taken to deal with the outbreak. He took with him a skilled rat-catcher, and also the necessary outfit for bacteriological examination of infected material. The latter work was undertaken by Dr. Woolnough, of Kempsey, who was formerly a medical officer of the Coast Hospital, Sydney, and while there had charge of the plague wards. At Kempsey he had medical charge of the 4 cases, and also examined all rats brought in by cleansing gangs or by private individuals.

Cleansing and disinfection of premises was carried out as in other outbreaks elsewhere in the State. The work was begun on 2nd February, and continued until its completion on 6th March. It may be summarised as follows:—

Premises searched and cleansed...	164
Drayloads of rubbish removed	205
Premises cleansed by occupiers	45
Expenditure	£243

By Executive Minutes dated 4th February and 6th February, 1907, the Board of Health was authorised:—

1. To take whatever action may be considered necessary for the cleansing and disinfection of Maclean's produce store.
2. To prevent the removal of grain and fodder from stores in Central Kempsey until such premises have been thoroughly searched for the presence of rats.

Immediately on the diagnosis of the first case the Kempsey Municipal Council caused a 6-feet galvanized iron fence to be erected, enclosing Maclean's produce store, with the view of preventing egress of rats, but in the cleansing of these premises (2nd–6th February) only 3 rats were obtained, 1 being killed by the gang and the other 2 found dead and putrid.

Accommodation of Patients.—Case A was treated at his own residence and died there. The others were treated at the Kempsey Hospital, Cases B and C in the isolation cottage, and Case D (the matron) in her own cottage.

The

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF KEMPSEY.

Showing the places at which plague-infected rodents were taken in 1907, the places at which persons who had plague were employed, and the places where they resided.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ● 5

Places at which persons who had plague resided

Shewn thus Ⓐ

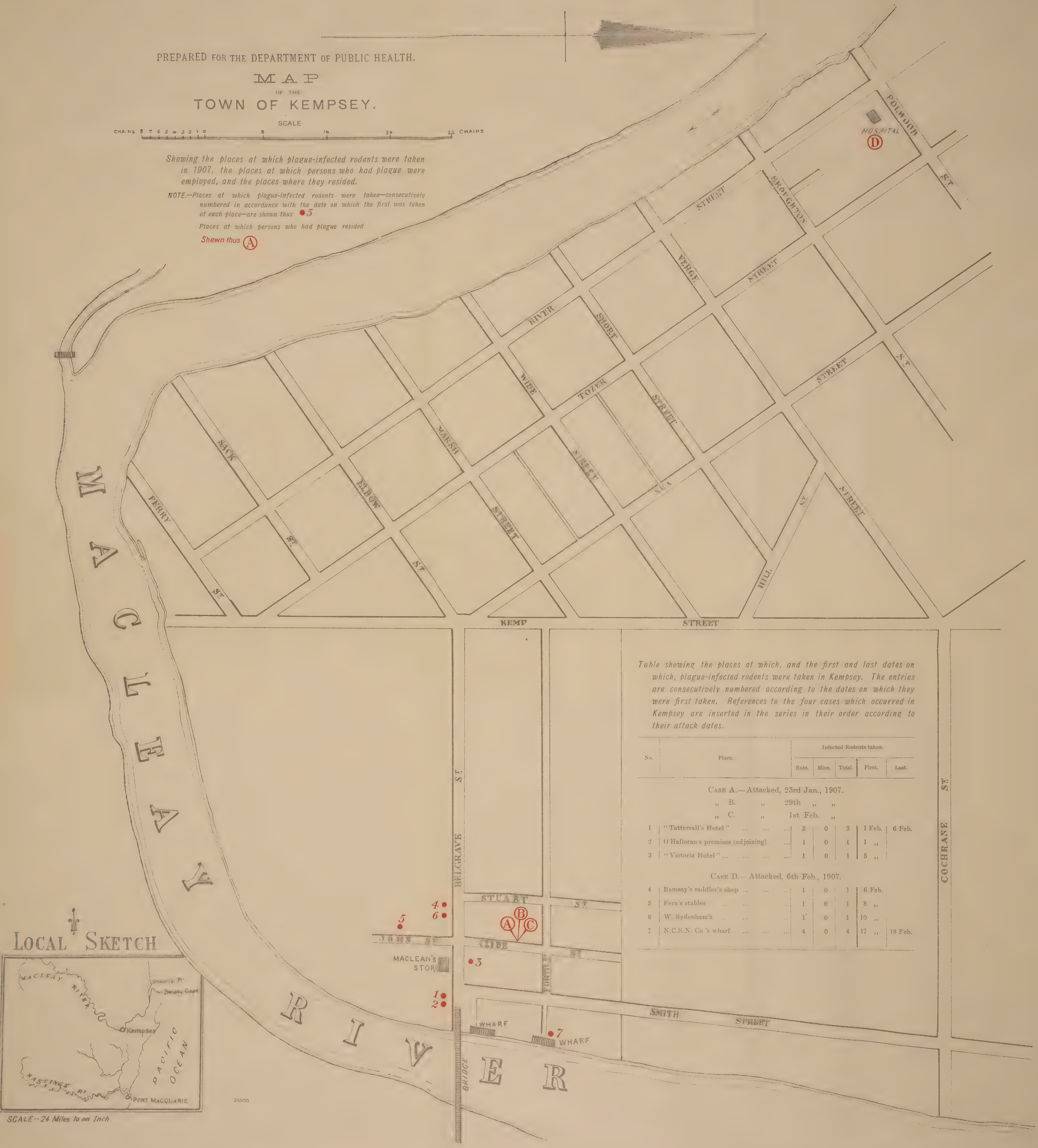

Table showing the places at which, and the first and last dates on which, plague-infected rodents were taken in Kempsey. The entries are consecutively numbered according to the dates on which they were first taken. References to the four cases which occurred in Kempsey are inserted in the series in their order according to their attack dates.

No.	Place.	Infected Rodents taken.				
		Rats.	Mice.	Total.	First.	Last.
	Case A.—Attacked, 23rd Jan., 1907.					
	,, B. ,, 29th ,, ,,					
	,, C. ,, 1st Feb. ,,					
1	"Tattersall's Hotel"	3	0	3	1 Feb.	6 Feb.
2	O'Halloran's premises (adjoining) ...	1	0	1	1 ,,	
3	"Victoria Hotel"	1	0	1	5 ,,	
	Case D.—Attacked, 6th Feb., 1907.					
4	Ramsay's saddler's shop	1	0	1	6 Feb.	
5	Fern's stables	1	0	1	8 ,,	
6	W. Sydenham's	1	0	1	10 ,,	
7	N.C.S.N. Co.'s wharf	4	0	4	17 ,,	18 Feb.

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

The Mayor (Alderman A. C. Small) and the Town Council acted with unusual energy and intelligence, and to this the summary extinction of the outbreak is largely ascribable. Their operations were directed in general by Dr. Woolnough, formerly Senior Resident Medical Officer, Coast Hospital, who was appointed by the Board to be its local representative, and in executive work by Mr. Lloyd (Cert. Royal Sanitary Institute), one of the Sanitary Inspectors attached to the Central Department of Public Health. At a certain date the Medical Officer of Health, Hunter River Combined Sanitary Districts (Dr. R. Dick, M.B., D.P.H.), was directed by the President (Dr. J. Ashburton Thompson) to pay a flying visit of inspection for further information of the Board.

APPENDICES.

APPENDIX A.

NOTE.—It is to be understood that none of the patients mentioned below had had any former attack of plague, had at any time been protected with Haffkine's prophylactic or otherwise, nor had had any communication with cases which preceded theirs, unless the contrary is stated.

Consecutive numbers are assigned in order of date of notification; capital letters connect the cases with the Diagrams; "d" following capital letters means "died."

Case 1 (A).

Summary.—B.M.E., m., æt. 21, single, clerk. Residence, Five Dock; employment, W. M. Cameron & Co., 20, Barrack-street, City. Notified by Dr. Allen, 8th January, 11 a.m. Visited (Dr. W. G. Armstrong, M.B., D.P.H., Medical Officer of Health, Metropolitan Combined Districts), 2 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 6th February; duration of illness, 30 days. Left femoral bubo of the size of an almond; extremely tender; films and cultures positive. Lesions of drainage area, a perfectly healed abrasion of left shin, said to have been inflicted on 26th December while bathing.

*Movements before Attack.**—His work does not take him out of his office, and has been nowhere but between his office and home since 1st January, when he visited a theatre.

Attack.—Having gone to bed in good health, awoke on 7th January with malaise, headache, and pain in the groin. Went to his office, but was obliged to go home again very soon.

Residence.—A detached wooden cottage in good repair, clean; pail closet; no trade; no stable, and none near.

Employment.—A warehouse, in which dried fruits and hops stored; in a terrace, brick, three stories and basement. An old building in fair repair.

Rats.—At residence, no traces; at employment, the lower part of the wall in the basement was perforated by rats, and there were abundant traces of past infestation, but only 2 rats and 1 mouse (all of which were negative), and 1 dried carcase, were collected.

Connected Cases.—None.

Case 2 (D).

Summary.—W.D.S., m., æt. 32, contractor, married. Residence, 22, Newland-street, Waverley; employment, was engaged in dismantling Sargent's restaurant premises at 80, King-street, City, preparatory to reconstruction; last attendance, 17th January. Notified by Dr. Walton Smith, 18th January, 10 a.m.; visited (Assistant Medical Officer of Government, Dr. R. J. Millard, M.B., D.P.H.), 11 a.m.; admitted to Coast Hospital, 4 p.m.; discharged, 23rd February; duration of illness, 37 days.

Movements before Attack.—From the tenth day to the sixth before attack was superintending alterations at 11, Hunter-street (plague-free premises); on the fifth day stayed at home; on the fourth day began work at 80, King-street, and continued.

Attack.—Worked all day 17th January; felt unusually tired during evening; went to bed at 9 o'clock, and then discovered tenderness in left groin. On 18th, morning, was found to have a small left femoral bubo; tender. Films and cultures made with material then withdrawn, negative; cultures made with the same taken 21st, negative; the same 22nd, cultures and inoculation, positive. Lesions of drainage area, two flea-bites on left thigh. A blood-film made 18th showed presence of well-marked neutrophile leucocytosis.

Residence.—No note.

Employment.—The premises, in the heart of the city, which he was dismantling, were a three-storey brick building in good repair, with an extensive, light, and well-fitted basement used by customers; the basement had a 4-foot wainscoting of matched boarding, which afforded ample signs of infestation with rats. At back the premises opened on a branch of Bank-court.

Rats.—The basement (as above) and the upper floors all presented evidence of present infestation. On 15th January patient found 2 dead rats, which were burnt without being submitted; but on 10th January, 3, and on 15th, 1 plague-infected carcases had been collected in Bank-court.

Connected Cases.—With the patient, none; with the locality in which he worked, see account of the Bank-court group in the text.

Case 3

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* The statement under this heading extends in every case to the ten days which preceded the day of attack.

CASE 3 (I).

Summary.—H.M., m., æt. 37, plumber, married. Worked on the same premises as Case 2. Residence, Mitchell-street, St. Leonards; employment, was engaged in dismantling 80, King-street, City; last attendance, 23rd January. Notified from the Coast Hospital, where he presented himself 23rd January, 11 a.m.; discharged, 19th February; duration of illness, 27 days. Left femoral bubo; films negative, cultures and inoculation, positive. Lesions of drainage area, a few small healed abrasions, and a few lesions of the size of a pin's head, which may have been flea-bites.

Movements before Attack.—Had been employed at Sargent's dismantled restaurant premises, at 80, King-street, for nine days before attack, and had visited another shop under the same management twice, four days and one day before attack. Also visited a rifle range on the fourth day before attack.

Attack.—Was well on 22nd. On rising at 5·30 a.m., 23rd, noticed a small, tender swelling in the left groin; went to work; nausea prevented him from taking food; ceased work at noon, and went to the Coast Hospital, ostensibly to visit W.D.B., but sought advice for himself and was detained. On admission looked rather ill; flushed; conjunctival injection; p. 112, compressible; the bubo was then the size of a marble, moderately tender, and there was already some periadenitic effusion.

Residence.—No note.

Employment and Rats.—See Case 2.

Connected Cases.—With the patient, none; with the locality in which he worked, see account of the Bank-court group in the text.

CASE 4 (G).

Summary.—H.W., m., æt. 30, cook, single. Residence, 206, Cumberland-street, City; employment, Sargent's restaurant, 390, George-street, city; last attendance, 22nd January. Notified by Sydney Hospital, 25th January, 3·30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 26th, mid-day; discharged, 28th February; duration of illness, 37 days. Large left femoral bubo filling Scarpa's triangle, skin reddened; films, cultures, and inoculation, positive. Lesions of drainage area, several minute abrasions and flea-bites.

Movements before Attack.—At home and at work. Tenth day, before attack, visited a public park; ninth day, worked for an hour at removing utensils from 80, King-street (see Cases 2 and 3); otherwise worked at the George-street building.

Attack.—22nd January—On leaving work at 8 p.m. first noticed swelling and sudden stiffness in the left groin; at 9·30 had a rigor and vomited; passed a restless night; occipital headache. 23rd—Stayed in bed, but got up in the afternoon; headache, vomiting, giddiness, and increased size of bubo; restless night. 24th—The same symptoms, plus depression of spirits, marked thirst, and offensive taste; visited the Botanical Garden during the afternoon; restless night. 25th—Admitted to Sydney Hospital.

Residence.—An old but good house in process of renovation.

Employment.—See general account of the Bank-lane group, to which this case belonged, in the text.

Rats.—At residence, the conditions mentioned above prevented detection of the usual state. At employment, see the general account.

Connected Cases.—With the patient, none; with the locality in which he worked, see Bank-court group, in the text.

CASE 5 (F, d).

Summary.—V.M.S., f., æt. 19, single, draper's assistant. Residence, 31, Yule-street, Petersham; employment, Waters & Co., 394, George-street, City. This patient, who was subject to fits of some sort, fell ill while at work 21st January. She was first seen by Dr. T. W. Lipscomb on 24th January, and she died early on 26th January. Her case was notified after her death, and her body was removed to a public mortuary, where a *post-mortem* examination was made by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor), who forwarded specimens taken from the spleen and from the cervical glands on the left side, which had become tumefied on 25th January. Films, cultures, and inoculation, positive.

Residence.—Brick cottage, detached, one storey, 5 rooms, connected with sewers; repair and cleanliness, fair, but damp.

Rats.—At residence, no signs; many fleas. At employment, see general account of the back lane group, in the text.

NOTE.—See also the account of the Yule-street group, with which this case was connected, in the text.

CASES 6 AND 7 (B, d, and C, d).

The illness from which these two patients suffered and died was registered as "pneumonia." The physicians in attendance upon them subsequently agreed that it had probably been primary plague pneumonia. Associated cases were Mrs. Lock's and Ma Kong's (Nos. 8 and 9, below), which formed the Campbell-street group.

Case 6.—Thomas Chong Wing On worked for Lock (also Chinese) as foreman, buyer, &c., in the produce trade. He lived at an unnumbered house in Parker-street, close by Campbell-street. His business caused him to frequent the produce wharves at Darling Harbour, which were known to be infected at the time of his attack. 9th January—Was married to a sister of Mrs. Lock (Case 8); in the afternoon went to Manly by water for the honeymoon; was taken ill on board the boat. 10th January—Was visited by a medical man. 12th January—Seemed a little better. 13th January—Died. Registered cause of death, pneumonia.

Case 7.—Mrs. May Chong Wing On, wife of Thomas Chong Wing On. She was in close attendance on her husband during the whole of his illness. 15th January—Fell ill in the evening. 16th January—Was visited by medical man; she had a T. 106°, and was vomiting. 17th January—Was removed to a private hospital. 19th January—Died at 2·30 p.m. Her sister, Mrs. Lock (Case 8), was almost constantly with her during the whole of her illness.

Connected Cases.—Nos. 8 and 9; see account of the Campbell-street group in the text.

Case 8 (H, d).

Summary.—K.L., f., æt. 22, housewife, married. An Australian native, born of Chinese parents. Residence, 24, Campbell-street, City. Was sister to Mrs. Chong Wing On (Case 7). Notified by Dr. Sawkins, 26th January; visited (W.G.A.), 11 a.m.; admitted to Coast Hospital, 9 p.m.; died, 27th January; duration of illness, about 6 days. No bubo; films made with peripheral blood on 26th, negative. *Post mortem.*—Lungs normal; cultures made from liver and spleen positive, from heart's blood, negative; inoculation, positive. Delirium was excessive, though not maniacal.

Movements before Attack.—Probably the patient remained at home during the ten days before her attack, save when she attended her sister, Mrs. Chong Wing On (Case 7), who died of plague, 19th January. To private hospital, 24th January.

Attack.—She sought advice on the 24th; she said she had caught cold at her sister's funeral on the 21st.

Residence.—A good brick terrace house, occupied, as to the first floor, by patient, in other part as lodging-room for 9 Chinese labourers, and in other part as a store for bananas, pea-nuts, maize, rice, &c., in which her husband traded.

Rats.—At residence, which was new and in good condition, no basement, ground-floor concreted, there were two rat-holes on the first floor which appeared to be old, and there were no signs of present or past infestation.

Connected Cases.—See account of the Campbell-street group, to which this case belonged, in the text.

Case 9 (J).

Summary.—Ma Kong, m., æt. 28, labourer, single. Residence and employment, 24, Campbell-street, City. Notified from Callan Park Asylum, 26th January, 11 a.m.; visited (R.J.M.), 2·15 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 2nd April; duration of illness, about 70 days. Left femoral bubo; films and culture-positive. Lesions of drainage area, several not recent scratches and abrasions on the leg.

Movements before Attack.—No history could be got, but see below.

Attack—The patient was in apparent good health when, on the morning of 25th January, he suddenly became excited and violent, and attacked his housemates with an axe. The police were called in, and removed him to the Reception House, where he continued violent until late in the afternoon. The Second Government Medical Officer for Sydney (Dr. G. H. Taylor) visited the Reception House in the ordinary course of duty, and reported that he was then quiet, in a state of abject terror, and under delusions of persecution; he had no fever, and the cause of a large femoral bubo was not inquired into. The same day he was transferred to an Asylum for the Insane. On 26th January he was reported thence to be quiet and rational, and to have a bubo for which no external cause could be found; examination with plague in view was requested. Two other medical men who examined him during the violent delirium saw no sign of general disease, and thought him insane. At discharge from hospital he was perfectly sane.

Residence and Employment.—See Case 8.

Rats and connected Cases.—See account of the Campbell-street group, to which this case belonged, in the text.

Case 10 (E).

Summary.—V.B., m., æt. 39, married, lift-man. Residence, 39, View-street, Woollahra; employment Sargent's restaurant, 290, George-street, City. Notified by his employer, 28th January, 9 a.m.; examined by the Assistant Medical Officer of Health, Metropolitan Combined Districts, 10 a.m.; admitted to Coast Hospital, 1 p.m.; discharged, 10th February; duration of illness, 23 days. Right femoral bubo, quiescent at date of examination; films and culture, negative.

Movements before Attack.—Was either at work or at home for ten days before attack.

Attack.—Was suddenly attacked at 4 p.m., 18th January; headache, vertigo; bubo first observed about 24 hours later; stayed at home (in bed for 2 or 3 days only) until 28th; on returning to work was then desired by his master to report himself.

Residence.—A brick cottage of 5 rooms, in a terrace, clean, in good sanitary state, connected with sewers; no stables near.

Employment.—See account in the text of the group to which this case belonged.

Rats.—At residence, no signs; at employment, see account in the text.

Connected Cases.—With the patient, none; with his place of employment, see account of the Bank-court group in the text.

Case 11 (M).

Summary.—G.E., f., æt. 17, single, waitress. Residence, George-street, Burwood; employment, Sargent's restaurant, 390, George-street, City. Notified by Dr. Blaxland, 27th January, 9 p.m.; visited (R.J.M.), 9·30 a.m., 28th January; admitted to Coast Hospital, 6 p.m.; discharged, 24th February; duration of illness, 28 days. No definite bubo, but there was some fulness of the left cervical region; films made 28th, negative; cultures, no growth. Peripheral blood taken 29th and 4th February, films and cultures negative.

Movements before Attack.—Between home and employment only.

Attack.—26th was well, but very tired at night; at waking 27th, giddy, vomited; at 11 a.m., T. 103°; in the afterpart of the day became dull, and eventually semi-comatose; T., 8 p.m., 105°.

Residence.—Detached brick cottage, clean, good sanitary state, connected with sewers; no stables near.

Employment.—See account in the text.

Rats.—At residence, no signs; employment, see text.

Connected Cases.—With patient, none; with her place of employment, see account of the Bank-court group in the text.

CASE 12 (N).

Summary.—L.C., f., æt. 17, single, waitress. Residence, 96, Sutherland-street, Paddington; employment, Sargent's restaurant, 390, George-street, City. Notified by Dr. Walton Smith, 28th January, noon; visited (R.J.M.), 12·45 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 17th February; duration of illness, 22 days. Bubo just above Poupart's ligament in the right groin; small, and so tender that it could not be punctured. Blood drawn from a finger-tip yielded negative results on direct and cultural examination.

Movements before Attack.—Between home and employment only.

Attack.—26th, well; 27th, rigor at 5 a.m., severe abdominal pain, accompanied later by severe headache and backache; at 11 a.m. T. 104°, and at 8 p.m. 105°; 28th, 5 a.m., 105°, groin became painful.

Residence.—Two-storey brick house, in terrace, good sanitary state, connected with sewers; no stables near.

Employment.—See account in text.

Rats.—At residence, signs of past infestation in the shape of burrows beneath the dividing fence; the adjoining premises on one side were said to be extensively rat-infested. At employment, patient had seen and heard of many dead rats, but had not touched them.

Connected Cases.—With patient, none; with place at which she worked, see account of the Bank-court group in the text.

CASE 13 (K).

Summary.—L.D., f., æt. 17, single, a waitress. Residence, 3, Little Wyndham-street, Alexandria; employment, Sargent's restaurant, 390, George-street, City; last attendance, 24th January. Notified by absence from place of employment, 28th January; visited (T.W.S.), 2·30 p.m.; admitted to Coast Hospital, 6 p.m; discharged, 17th February; duration of illness, 24 days. Right inguinal bubo, marked tenderness, no pain, moderate periadenitic effusion; films, cultures, and inoculation, negative. Lesions of drainage area, none.

Movements before Attack.—Between home and employment only.

Attack.—Having been well 24th, was suddenly attacked 25th, 7 a.m., with headache and general pains; the groin was first noticed to be tender, 27th. At examination, 28th, P. 84, R. 20, T. 100·2°, dull and torpid, conjunctivæ injected, pupils dilated, arterial tension low; extreme tenderness of the bubo prevented abstraction of liquid from it till 30th January (see above).

Residence.—Wooden cottage, detached, clean, good sanitary state, connected with sewers; no stables near.

Employment.—See text.

Rats.—At residence, one hole in passage was the only evidence of past infestation. Employment, see text.

Connected Cases.—With patient, none; with place at which she worked, see account of the Bank-court group in the text.

CASE 14 (L, d).

Summary.—E.F., m., æt. 27, single, working jeweller. Residence, 258, Liverpool-street, City; employment, Flegeltaub, jeweller, 96, King-street, City; last attendance, 26th January. Notified by Dr. Hall, 30th January, noon; visited (R.J.M.), 12·30 p.m.; admitted to Coast Hospital, 5 p.m.; died 2nd February; duration of illness, 8 days. No bubo; no cough or sputum; blood from right middle finger, 30th, film negative; culture and inoculation, positive; blood from right ear, 31st, film negative, culture overgrown, inoculation positive.

Movements before Attack.—Between home and employment only.

Attack.—25th, was well; 26th, suddenly attacked, 8·30 a.m., giddy and weak on his way to work, vomiting, headache; returned home, has been in bed ever since. Form, septicæmic; on 1st February a soft, diffuse, swelling appeared below left ear, which was afterwards found to enclose a swollen cervical gland surrounded by moderate effusion, in which *B. pestis* in number were demonstrated in films, and obtained pure in culture. Abdominal distension and tympanites, constipation, during the last 48 hours jaundice, albumen and bile in urine. *Post mortem*—Lungs, hypostatic congestion of both bases, at each apex a patch of consolidation with old pleuritic adhesions (tuberculosis); stomach contained black liquid, intestines distended, mesenteric glands not enlarged, external iliac glands enlarged to 3 or 4 times the normal size, but normal in colour, and devoid of periadenitic effusions; liver, moderately enlarged, pale, and bile-stained; spleen enlarged, but normal in colour and consistence; heart, punctate hæmorrhages in pericardium. Films made from liver and spleen were negative, but cultures yielded a positive result; lungs, films and cultures negative; left cervical gland (see above) and right inguinal gland films positive; inoculation with the gland substance, positive.

Residence.—A good brick house, in a terrace, connected with sewers.

Employment.—Good structural condition, basement concreted.

Rats.—At residence, no signs; at employment slight evidences of infestation, 1 rat only taken, which was healthy.

Connected Cases.—With patient, none; with locality in which employed, see account of the Bank-court group in the text.

CASE 15 (O).

Summary.—D. O'C., f., æt. 7, school. Was in communication with V.M.S. (Case 5). Residence, 24, Yule-street, Petersham; school, Crystal-street; State school near by. Notified by Dr. Jenner, 7th February, 3·30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 9·30 p.m.; discharged, 6th March; duration of illness, 29 days. Bubo: fulness and tenderness in Scarpa's triangle, right side, but no definite bubo; 8th February—Culture negative; 11th—Peripheral blood (ear) films, cultures, and inoculation, negative; 18th—Culture again made from right groin, negative. Lesions, a few marks as of old flea-bites.

Movements before Attack.—Between home and school, and playing in the street.

Attack.—5th February—Well. 6th—Complained of headache at waking, 6 a.m., vomited at 9 a.m.; in the evening pain in right groin; at 11 p.m. T. 104°. 7th—On examination P. 156, R. normal, T. 103°, prostrate; lies with right thigh flexed and rotated outwards.

Residence.—A brick semi-detached cottage, one storey with an attic, repair and cleanliness fair, connected with sewers; a poor property; no stables near.

Rats.—Sign of past infestation, one rat-hole in sitting-room.

Connected Cases.—See account of the Yule-street group, to which this case belonged, in the text.

Note.—See also Case 5, which was associated with the Yule-street group.

Case 16 (P, d).

Summary.—A. O'C., f., æt. 9, school. Was in communication with V.M.S. (Case 5) and her sister, D. O'C. (Case 15). Notified by Dr. Jenner, 7th February, 3·30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 9·30 p.m.; died 8th February; duration of illness, 56 hours. Form, septicæmic; blood from left ear taken 8th February, films, culture, and inoculation, positive.

Movements before Attack.—Between home and school, and playing in the street.

Attack.—6th February, 3·30 p.m. at school, vomited and was sent home, became feverish; at 11 p.m. T. 104°. 7th—Only semi-conscious, restless, resisted examination, face flushed, P. 144, R. normal, T. 103·2°; no other symptoms.

Residence.—See Case 15.

Residence, Rats, and connected Cases.—See account of the Yule-street group in the text.

Case 17 (Q).

Summary.—M.M., f., æt. 26, single, waitress. No former attack; not inoculated; no connection with any previous case. Residence and employment, "Empire Hotel," corner of Hunter and Pitt streets, City. Notified by Dr. Muller, 8th February, 4·40 p.m.; visited (R.J.M.), 5 p.m.; admitted to Coast Hospital, 9·30 p.m.; discharged, 27th March; duration of illness, 50 days. Right inguinal bubo; films and culture positive.

Movements before Attack.—Only left the hotel occasionally for trips on the harbour by ferry-boats to places which were not infected.

Attack.—6th February, general malaise and pains, but continued at work; 7th, worked, but felt worse; towards evening felt pain in right groin; 8th, stayed in bed; on examination, P. 140, R. normal, T. 104·8°, prostrate, face flushed, bubo very tender; some deep-seated tenderness of higher inguinal glands. Lesions, none; a small abrasion of right tibia.

Residence and Employment.—A fine stone building of four floors, with a basement or large cellar, connected with sewers, in good structural state. Domestic management: as regarded the public premises quite good; as regards servants and kitchen quarters (the latter on the fourth floor), dirty and neglected; on the roof a hut had been built, which was full of useless lumber.

Rats.—There were abundant signs of infestation in the hut on the roof, on the kitchen floor, in a staff dining-room and a store, on the third floor in a bedroom, a bathroom, and a housemaids' cupboard, on the second floor in a cupboard and in a bedroom, on the first floor in a public dining-room and a pantry. Between 5th and 28th January these premises had been under notice of the Local Authority for the City by whose rat-staff 13 *M. decumanus*, 3 *M. rattus*, had been referred to the Board's laboratories, all of which had proved negative; but on 29th January 1 *M. decumanus*, and on 9th February 1 *M. musculus*, were brought in, in which plague was identified. A few putrid carcases were collected after occurrence of this case, and the patient reported that other carcases had previously been removed and destroyed.

Connected Cases.—None; another servant slept in the same room as the patient.

Case 18 (T).

Summary.—I.R.I., f., æt. 37, married, lodger. Residence, "Standard Hotel," corner of Bathurst and Castlereagh streets, City. Notified by Dr. W. E. Warren, 12th February, 10 a.m.; visited (R.J.M.), 10·30 a.m.; admitted to Coast Hospital, 3 p.m.; discharged, 6th March; duration of illness, 25 days. Right inguinal bubo, films and culture positive. Lesions, many flea-bites.

Movements before Attack.—Has lodged here about ten weeks; during ten days before attack walked occasionally in the city, and entered shops.

Attack.—10th February was in usual health till 4 p.m. when she had a rigor; went to bed at once; headache; pain in right groin first noticed during evening; at examination, P. 132, R. normal, T. 104·2°.

Residence.—An old brick public-house of 28 rooms and a basement; badly infested with fleas.

Rats.—Badly infested; many plague-rats found.

Connected Cases.—See account of the "Standard Hotel" group in the text.

Case 19 (R).

Summary.—J.F., m., æt. 18, single, generally useful. Residence and employment, "Royal Standard Hotel." Notified by Dr. Warren, 12th February, 10 a.m.; visited (R.J.M.), 11 a.m.; admitted to Coast Hospital, 17th February, 4 p.m.; discharged, 26th March; duration of illness, 46 days. Small right inguinal bubo, moderately tender; films, negative; culture, one colony of *staphylococcus albus*; inoculation 12th February, g.-p. No. 1,443 died of plague, 17th February. Lesions, a single pustule on the back was not bacteriologically examined; on the inner aspect of the right ankle there was some tender rather soft swelling with deep redness of the overlying skin; less marked redness extended from it 2 or 3 inches up the leg; not bacteriologically examined.

Movements before Attack.—Constantly employed at the public-house, occasionally bathed at Bondi, and walked about town in his off time.

Attack.—9th February was well, but during the afternoon noticed slight soreness of the right groin; no other symptoms. 10th, evening, found slight swelling in groin. No other symptoms occurred till 16th February, when a spot at the inner side of the right ankle rather suddenly became red and swollen. No constitutional disturbance occurred throughout.

Residence, Employment, Rats, and connected Cases.—See account of the "Standard Hotel" group, in the text.

Case 20

CASE 20 (S).

Summary.—G.S., m., æt. 41, married, a plumber. Residence, 20, Burrapore-street, Woolloomooloo, City; employment, Thomas and Osgood, plumbers, 216, Castlereagh-street, City; last at work, 8th February. Notified by police, 12th February, 5 p.m.; visited (G.H.T.), 5·10 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 13th March; duration, 33 days. Right femoral and inguinal bubo; the femoral glands obscured by effusion and matter together, the inguinal enlarged but discrete; films and culture positive. Lesions, a few minute abrasions and pin-point stains.

Movements before Attack.—8th and 7th February worked on a job at 161–3, Oxford-street; on 6th and 5th at Usher's hotel, King-street, City; during six days before that at the Protestant Hall (which only 4 doors from "Royal Standard Hotel," Cases 18, 19, &c.).

Attack.—9th February was suddenly attacked at noon, dizziness, headache, feeling of weakness; went home, at night shivered and vomited, and during the night was slightly delirious; 11th, rather better; 12th, only moderately ill, no fresh symptoms, feeling of extreme weakness.

Residence.—A good brick cottage, connected with sewers; in fair order.

Employment.—Various places as mentioned above. See under "Rats" below.

Rats.—None actually found save at Usher's hotel, where he worked on 5th and 6th February; 8 *M. decumanas* were taken there in the ordinary course of rat-catching between 30th January and 5th February, and plague had been identified in 1 taken on 1st February; the premises were in excellent order.

Connected Cases.—None.

CASE 21 (V).

Summary.—V.I., f., æt. 8, at home (daughter of I.R.I., Case 18). Notified by Dr. A. M. Johnson, 14th February, and at the same time forwarded to the Coast Hospital, where she was admitted at 7·30 p.m.; discharged, 6th March; duration, 20 days. Left inguinal bubo; inseminated agar tubes submitted by Coast Hospital, 15th and 18th February, negative; serum submitted by Coast Hospital, 19th: films negative, culture overgrown by staphylococcus. Lesions, many flea-bites.

Movements before Attack.—Was with her mother (Case 18) at the "Royal Standard Hotel"; when her mother was removed to hospital she was sent (12th February) to stay with friends at Granville, a distant suburb; removed thence to hospital.

Attack.—13th February, first sign pain in groin, 9 p.m.; slept all night; 14th, eat no breakfast, afterwards vomited, lay about all day, no other signs; on admission to hospital, P. 140, R. 38, T. 102·4°, listless, and but slightly ill; the bubo of the size of a pigeon's egg, moderately tender.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 22 (U, d).

Summary.—G.B., m., æt. 55, servant. Residence and employment, "Royal Standard Hotel." Notified, 13th February, by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor), from the Hospital Admission Depôt, where patient had personally applied; admitted to Coast Hospital, 4 p.m.; died, 21st; duration of illness, 9 days. Septicæmic form; blood taken from right ear, 21st February: films and cultures negative; inoculation, g.p. 1,450, died of plague on the ninth day. Lesions, none.

History of Illness.—12th February.—While in usual health was suddenly attacked with acute pain in the loins at 11·30 p.m.; afterwards headache, shivering, no sleep. Got up at 5 a.m. 13th, but was unable to work. *Post mortem.*—At anterior border of right lung was a solid and hæmorrhagic patch which measured about 2 in. x 1 in., but the lungs were otherwise not affected; liver, much enlarged and studded on surface and throughout substance with hæmorrhagic infarcts about one-fourth of an inch in diameter; spleen, much enlarged, parenchyma dark in colour and almost liquid; intestines, the lower part of the ileum showed congestion mainly in the neighbourhood of its mesenteric attachment, Peyer's patches not enlarged; one mesenteric gland was slightly enlarged. The liver and portion of lung teemed with *B. pestis*, while the spleen yielded it in less numbers.

Movements before Attack.—Was constantly employed at the hotel; went out for an hour occasionally only.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 23 (W).

Summary.—E.F., f., æt. 24, single, barmaid. Residence and employment, "Royal Standard Hotel," City. Observed at residence (T.W.S.), 15th February, 5 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 27th February; duration of illness, 14 days. Left femoral bubo, small, over saphenous opening, too tender for puncture. Lesions, several flea-bites.

Movements before Attack.—Remained strictly at home.

Attack.—Attacked 14th February, suddenly; at 7 p.m. had a rigor; pain at site of bubo first felt 15th.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 24 (Y, d).

Summary.—H.W.K., m., æt. 19, single, messenger. Residence, 74, Curtis-road, Balmain; employment, Stewart, Dawson, & Co., jewellers, 412, George-street, corner of Strand Arcade, of which the premises formed a part. Notified by Dr. Campbell, 17th February, 11 a.m.; visited (T.W.S.), 12·30 p.m.; admitted to Coast Hospital, 7 p.m.; died 25th February; duration of illness, 9 days. Right femoral bubo; cultures positive. A few miliary lesions of drainage area.

Movements before Attack.—Had been regularly at work; carried messages to many different places, including some wharves.

Attack.—Attacked suddenly 16th February, 10·30 a.m., shivering, headache, pain in back and neck, delirium at night; 17th, first felt pain in right groin.

Residence.—A two-storey brick house, in terrace, general sanitary state and cleanliness good, connected with sewers; no stables near.

Employment.—A retail jeweller's; large shop and an office on ground floor, workshop and small store over; structural condition, &c., very good; basement concrete under the greater part of the arcade, at entrance to which these premises stood.

Rats.—At residence, no signs. Employment: The caretaker at the arcade had been setting traps on these and other premises for many months, but specimens were not submitted. Between 7th and 11th February 5 *M. decumanus* were submitted by L.A. for the city, and were not infected; in the shop were two or three rat-holes, and rats had a run up a small hand-lift shaft; patient reported that 3 dead rats had been removed from beneath the office floor in the shop about a week before.

Connected Cases.—None.

CASE 25 (Z).

Summary.—H.J., m., æt. 36, widower, barman. Residence and employment, "Royal Standard Hotel." Notified by friends, 18th February; visited (T.W.S.), 11·30 a.m.; admitted to Coast Hospital, 2 p.m.; discharged, 21st March; duration, 33 days. Right femoral bubo; films negative, cultures and inoculation positive. Lesions of drainage area, flea-bites and small healed abrasions.

Movements before Attack.—Constantly at place of employment; usually went for a swim every morning.

Attack.—Attacked suddenly 16th February, 6 a.m., retching and headache; returned to bed; drowsy; some shivering; about 10 a.m. noticed pain, tenderness, and swelling in the right groin.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 26 (X, d).

Summary.—G.L., Chinese, m., æt. 47, married, cook. Residence, 11 Mary-street, Surry Hills; employment "Royal Standard Hotel." Notified by the Second Government Medical Officer for Sydney from the Hospital Admission Depôt; visited by temporary Assistant Medical Officer (Dr. C. S. Willis, M.B., D.P.H.), noon; admitted to Coast Hospital, 5 p.m.; died, 21st February; duration, 6 days. Left femoral and inguinal buboes; films and culture positive.

Movements before Attack.—Between home and employment only.

Attack.—Sudden, 15th February afternoon, shivering followed by fever, obliged to cease work at once; pain in groin first noticed about the same time.

Residence.—A cottage in good sanitary state.

Employment, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 26 (AA).

Summary.—C.G., m., æt. 54, widower, labourer. Residence, 3 Harbour-street, City (Darling Harbour); employment, a produce store at 345A Sussex-street; last attendance 20th February, 5 p.m. Notified by friends, 21st February, 2 p.m.; visited (W.G.A.), 2·30 p.m.; admitted to Coast Hospital, 7·30 p.m.; discharged, 21st March; duration, 30 days. Left inguinal bubo; films negative, culture positive. Lesions, a few flea-bites.

Movements before Attack.—Between house and above place of employment only, both in the same neighbourhood.

Attack.—20th February, at 4 p.m. first noticed stiffness and pain in the groin; headache followed, restless night; at examination was walking about his house.

Residence.—A four-roomed brick house, in a terrace, in fair repair and general sanitary state.

Employment.—A small store, consisting of a single room, paved partly with concrete, partly with stone; a small loft containing lumber; shingle roof.

Rats.—Patient found a dead rat while removing the roof 4 or 5 days before attack, but could not remember the date. Between 3rd January and 26th February 1 *M. decumanus*, 95 *M. rattus*, and 1 *M. musculus* collected on these premises had been submitted by the L.A. for the city. Were infected: 1 *M. rattus* 14th January, 1 each 4th, 5th, and 8th February, 3 (and 6 putrid) 11th, 2 on the 12th, 1 on the 14th, and 1 on the 26th; of *M. decumanus*, 1 on 4th February.

Connected Cases.—None.

CASE 28 (BB).

Summary.—F.J.F., m., æt. 45, married, carpenter. Residence, Railway-street, Rockdale; employment, various places (see below). Notified by Dr. McLeod, 23rd February, 4 p.m.; visited (C.S.W.), 6 p.m.; admitted to Coast Hospital, 11 p.m.; discharged, 11th May; duration, 81 days. Left femoral bubo; films and culture positive. Lesions, flea-bites on foot and left leg.

Movements before Attack.—From 14th to 21st February worked by day putting up shelves in a wine-cellar at the "Metropolitan Hotel" (see Case 20; that patient worked as a plumber at this hotel 5th and 6th February, as well as elsewhere; attacked 9th), but also from 6 to 9 p.m. at Hordern's drapery, Pitt-street, on the ground floor near the lift-well. Regularly at home after work.

Attack.—21st February, sudden during afternoon, shivering, frontal headache, weakness, unable to stand; slept well. Early on 22nd first noticed a tender swelling in the left groin.

Residence.—Detached weatherboard cottage of one storey in very good sanitary state; clean; pail closet; no stables near.

Employment.—The "Metropolitan Hotel" was inspected on 15th February, and again on the 25th, by different officers; it was reported to be in excellent condition throughout, including the cellar. Hordern's premises were also found to be in excellent order.

Rats.—At residence, no signs; at the hotel, no signs of infestation. At Hordern's, a dead rat was found under a fixture which was being moved on the evening of the 18th, which was destroyed at once; the patient was present, but did not touch it. However, there were no signs of infestation of these premises; the ground floor opened by a door on a lane at the back; this was open while work was going on, and this rat probably entered by the door and took refuge under the fixture.

Connected Cases.—None (if Case 20 were regarded as connected, it could be so only by locality).

CASE 29 (DD).

Summary.—A.P., m., æt. 23, single, butcher's carter. Residence, Telopea-street, Redfern; employment, No. 1, Pitt-street, Circular Quay. Notified by Dr. Binnie, 5th March, 11·30 a.m; visited (R.J.M.), 12·15 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 11th May; duration, 40 days. Left femoral bubo; films and culture positive. Lesions, a few pin-point, healed lesions of doubtful origin.

Movements before Attack.—Between employment and home; on 3rd March (Sunday) went into country and bathed.

Attack.—3rd March, sudden, 9 p.m.; after returning from the country in his usual health ate a good tea, and at 9 o'clock had a rigor, after which there was headache and general pains, sleepless night. 4th, at 1 p.m., T. 105·2°, at night, 105·8°; bubo first noticed during the morning.

Residence.—A three-storey brick house in good sanitary state, clean, connected with sewers; stable near; 107 Bourke street.

Employment.—A butcher's shop, wooden floor, cold storage, and a small yard; connected with sewers; at back, is divided from a fruit shop on George-street by a wooden fence.

Rats.—At residence, no traces; at the stable in Bourke-street, used by patient, infestation; no history of dead rats. At employment, the butcher shop was infested, as well as the fruit shop at back on George-street, but knowledge of dead rats was denied. Patient served one coasting vessel at Town's Wharf, foot of Bathurst-street, Darling Harbour, and many public-houses, including one where a plague-rat was taken 15th February. The block in which the shop stood abutted on Circular Quay, whence plague-rats were collected between 21st February and 15th March. Patient had not visited infected premises on the Quay.

CASE 30 (CC).

Summary.—G.J.C., m., æt, 27, married, no occupation. Residence, 441 Bourke-street, Surry Hills. Notified by Dr. Brandon, 5th March, 2 p.m.; visited (C.S.W.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 27th March; duration, 27 days. Left femoral bubo (two glands swollen); films and cultures positive.

Movements before Attack.—Was unemployed; took meals at restaurants in Pitt and in King streets (infected neighbourhoods); was accustomed to walk about the centre of the city, Circular Quay, &c., and once visited a gymnasium in a distant and not infected suburb.

Attack.—1st March, at waking noticed pain and tenderness just below left groin at site of present swelling; this increased on the 2nd, but constitutional symptoms first began, and suddenly, at 8 p.m. on the 3rd, shivering, giddiness, headache, general pains, vomiting, and a restless night.

Residence.—A brick house of 8 rooms in a terrace, occupied as a boarding-house, in fair structural state and good order, connected with sewers; a well-kept stable 2 doors away; the nearest produce store 200 yards away.

Rats.—At residence, infestation with mice admitted and observed, but no trace of present infestation with rats, though 2 or 3 rat-holes were present. No rats were afterwards collected. No evidence of presence of epizoötic plague was got anywhere near the site of these premises.

Connected Cases.—None.

CASE 31 (EE, d).

Summary.—S.C.D., f., æt 16, single, confectioner's packer. Residence, 6, Queen-street., Chippendale (City); employment, Dillon and Burrows' confectionery factory, 231–7, Harris-street, Ultimo (City). Suddenly attacked about 1 a.m, 4th March, rigor, for 12 hours was unconscious; 5th, appeared to be better; 6th, vomiting and purging, became comatose, was visited by Dr. Chapple, T. 103·6°; 7th, died at 2 a.m.; duration, 72 hours; Dr. Chapple declined to certify to the cause of death. Notified by Dr. A. A. Palmer from the morgue where he was examining the body under instructions from the Coroner; the Assistant Medical Officer of Government (R.J.M.) was directed to attend the post mortem. Mesenteric, femoral, and inguinal glands enlarged and hæmorrhagic; liver, congested; spleen, large but firm; no pneumonia; multiple hæmorrhages, large and small, over surface of body, and in all internal organs. Films and cultures from liver, spleen, femoral and mesenteric glands, positive.

Movements before Attack.—Between home and work only, save the evening of 2nd March, when she walked as far as Belmore Market. For at least a fortnight before attack had worked full time every day; was carefully looked after by her mother; the forewoman of her workroom lived at her mother's house.

Residence.—A three-roomed brick house in a terrace, very small, fair structural repair, moderately clean, connected with sewers; large stables, fronting another street, at the back; the house and neighbourhood very poor, and much occupied by factories. One or two rat-holes in a floor, no signs of present infestation, and no history of observed rat mortality.

Employment.—A large factory employing about 120 hands, mostly girls; in fairly good structural order, and cleanly kept. The firm have many retail shops, from which empties are returned to the factory for refilling; S.C.D.'s business was to reline empties with paper, lace, &c., for refilling. She had not visited any of the retail shops, two or three of which stood in infected neighbourhoods. It was ascertained that there had been rats about the factory, but at examination no evidence of infestation appeared; half a dozen cats were kept; traps were seen to be set about the place; no hint of recent mortality among them was got.

Connected Cases.—None at the factory; her mother (Case 36) and possibly T.R. (Case 34). See an account of the Chippendale group in the text.

CASE 32 (GG).

Summary.—F.D., f., æt. 23, single, dressmaker (?). Residence, 105, William-street (and 167, Bourke-street, immediately before), City; employment, none (or working at home). Notified from Sydney Hospital, 11th March, 10 a.m.; visited (R.J.M.) 10·45 a.m.; admitted to Coast Hospital, 4·45 p.m.; discharged 28th March; duration, 19 days. Left femoral bubo; films and culture negative (11th); film negative, culture and inoculation positive (16th); material abstracted from bubo on both occasions. Lesions of drainage area, a few old flea bites.

Movements before Attack.—Says she received material from one shop only, which never infected. Movements not traceable with any certainty, but dined at two or three different restaurants, none of which were known to be infected.

Attack.—9th March, sudden, 9·30 p.m., rigor and intense headache; 10th evening, P. 130, T. 105°, pain in left groin; 11th, bubo indefinite, fulness in Scarpa's triangle, but individual glands cannot be made out.

Residence and Employment.—A brick house in a terrace, three storeys, clean, good sanitary state, connected with sewers, used as a boarding-house; several stables near by, one large.

Rats.—At residence no signs of infestation.

Connected Cases.—None.

Case 33 (FF).

Summary.—F.McD., m., æt. 36, single, hawker of tinware in the city. Residence, Model Lodging House, 211, Kent-street, Darling Harbour. Employment, streets. Notified by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor) from the Hospital Admission Depôt, where he had presented himself, 12th March, 11 a.m.; visited (R.J.M.), 11·30 a.m.; admitted to Coast Hospital, 4 p.m.; discharged, 24th April; duration, 48 days. Right femoral bubo; films and culture positive. Lesions, a few flea-bites.

Movements before Attack.—Vague; can only say he has been off work for about a fortnight, at beginning of which he entered on a drinking-bout, and has occasionally not returned to his lodging but has slept in one of the parks.

Attack.—Thinks this occurred about the 7th March, when he had chills and muscular weakness, which he ascribed to drink.

Residence.—Detached brick house, five storeys, clean, general sanitary state good, connected with sewers; stands in the Darling Harbour area (patient's residences here seems to have occurred irregularly).

Rats.—Sign of past infestation only, in holes and runs in retaining walls visible in the yard; infestation of basement with mice; no mortality had been observed.

Connected Cases.—None.

Case 34 (HH).

Summary.—T.R., m. æt. 37, single, labourer. Address, 9, Milford-street, Chippendale; employment, out of work. Notified by Dr. Cooley, 17th March, 2·20 p.m.; visited (C.S.W.), 3·30 p.m.; admitted to Coast Hospital, 8·15 p.m.; discharged, 3rd April; duration, 19 days. Right inguinal bubo; films and culture positive. Lesions, a small healed abrasion, inner side of tibia.

Movements before Attack.—Visited many places in search of work, among which the foot of Druitt-street, Darling Harbour, where he waited about half an hour on 13th or 14th March, alone call for special remark, the epizoötic having been recognised there a few days after his attack. But he frequented other streets and buildings within the infected area, although he never took his meals away from home.

Attack.—15th March, went to bed in his usual health; 16th, was suddenly attacked 7 a.m., having been aroused by severe pains in head and back; at the same time he noticed a small tender swelling in the right groin.

Residence.—A two-storey brick cottage in a terrace, very clean, fair sanitary state, connected with sewers; two stables not far away, in good order.

Rats.—No signs of infestation, and presence denied; no infestation of the stables.

Connected Cases.—See account of the Chippendale group in the text; but compare place of infection in Case 39, *post*, which this patient visited.

Case 35 (JJ, d).

Summary.—M.L., m., æt. 20, single, cleaner, employed at several public-houses. Residence, 26, St. Mary street, Camperdown; employment, Law's hotel, corner of Pitt and King streets, City. Notified by Dr. Styles, 22nd March, 9·30 a.m.; visited (C.S.W.), 10·30 a.m.; admitted to Coast Hospital, 4·30 p.m.; died, 25th March; duration, 7 days. Left inguinal bubo; films and cultures positive; bloodstained (typical "prune-juice") sputum, negative. Lesions, a few old flea-bites and miliary lesions.

Movements before Attack.—Had been more or less regularly employed as scrubber and bar-cleaner at several public-houses, but his movements were not traced to any house known to be infected; four days before attack he entered on permanent employment at Law's hotel, but was discharged on the day of attack before he had fallen ill; he slept on the third floor, with other employed men.

Attack.—18th March, sudden, at some time during the afternoon; headache and shivering. 19th—Giddy, weak, and pain in left groin; died, 25th. *Post mortem.*—Right lung, normal; left lung, old adhesions of lobes to each other and to pericardial sac, rather deeply injected posteriorly, but contained air; films negative, culture overgrown; mediastinal glands dark chocolate colour, about the size of a bean, films positive, culture overgrown. Liver, apparently normal; gall bladder, many minute hæmorrhages under the peritoneal coat; films prepared from liver, positive; cultures overgrown. The tissues in front of the spine and along the iliac vessels contained extensive hæmorrhages which, on the left side, reached as high as the suprarenal capsule; the chain of glands which extends from the left iliac fossa upwards was completely fused, as also were those on the right side, where, however, no gland below was affected; films prepared from the enlarged glands, positive; cultures, overgrown. Spleen moderately enlarged, dark, firm; films, positive. The intestines appeared to be normal except for slight injection here and there, but the stomach exhibited numerous submucous and subperitoneal hæmorrhages, which were also present elsewhere in the abdomen.

Residence.—Weatherboard detached cottage, clean, fair sanitary state, connected with sewers (W.C. flush-pipe defective); no stable near by.

Employment.—The public-house at which deceased was employed continuously for four days, and where he slept on the three nights which preceded the day of his attack, stood within an infected area, and close to (though across a road from) the locality described under the Bank lane group. A handsome, but rather old, brick building of four storeys, in fairly good order, but having external openings which were not defended by wire netting in accordance with by laws.

Rats.—At residence, no signs; at employment, ample signs of past and of present infestation, but no carcases found, nor any rats trapped.

Connected Cases.—None.

Case 36

Case 36 (II).

Summary.—E.L.D., f., æt. 46, widow, at home. Lived in the same house with S.C.D. (Case 31) her daughter. Residence, 6, Queen-street, Chippendale. Notified by police, 21st March, 3·30 p.m.; visited (C.S.W.), 4 p.m.; admitted to Coast Hospital, 5 p.m.; discharged, 10th April; duration, 26 days. Right femoral bubo; films and cultures (21st) negative; 23rd, films negative, culture and inoculation positive. Lesions, old flea-bites.

Movements before Attack.—Constantly at home; went only to church five days before attack.

Attack.—16th March, sudden, 3 p.m.; after lifting a heavy box felt pain in the right groin, and found a lump there; shortly afterwards chilliness and weakness; went to bed; vomited. 17th, slight headache. A mild attack.

Residence, Rats, and connected Case.—See Case 31, and account of the Chippendale group in the text.

Case 37 (KK, d).

Summary.—E.P.R., f., æt. 27, single, house duties. Residence, "Hellespont," Lavender Bay, North Sydney. Notified by Dr. Studdy, 23rd March, 8·30 a.m.; visited (C.S.W.), 10 a.m.; admitted to Coast Hospital, 2·30 p.m.; died, 24th March; duration, 86 hours. Right femoral and left cervical buboes; the first formed a swelling about 3 in. x 2 in. in size, the second about 2½ in. x 2 in., much effusion around both; both painful, both extremely tender; on the right side of the neck was a slightly enlarged and rather tender gland. Films and culture made with contents of the right femoral bubo, positive. Lesions, mark of an old scratch, anterior surface of right leg.

Movements before Attack.—Was preparing for a long voyage, and consequently visited Sydney by North Sydney ferry nearly every day; went to several shops from time to time, and once at least lunched at a restaurant; but her movements, as far as they could be traced, did not take her to any place of known infection except that district at the centre of the city which carried plague-rats here and there, and except the wharf she crossed and sometimes waited at on the Sydney side. Often had to wait a few minutes for a boat, and on 19th (or 20th) March, having diarrhœa, stayed for some time in the women's lavatory, No. 5 jetty, Sydney side.

Attack.—21st March, sudden; having gone to the city feeling well had, at 10 a.m., a rigor, giddiness, a feeling of suffocation; soon afterwards vomiting and diarrhœa set in. First felt pain in the groin and neck 22nd.

Residence.—A 3-storey stone house of 15 rooms, used as a boarding-house; cleanliness good; general sanitary state indifferent. The Assistant Medical Officer of Health, Metropolitan District (Dr. T. W. Sinclair, M.D., D.P.H.), advised the Local Authority to serve notices requiring a trapped gully, provision of permanent ventilation to certain rooms, repair of defective woodwork and paving, &c., &c., and to make the premises as far as possible rat-proof.

Rats.—At "Hellespont," no signs of present infestation, but there were old rat-holes; proprietor said 3 rats had been trapped during the preceding six weeks; many traps set by staff on six nights resulted in capture of 1 *M. rattus*, negative, only; from the next (detached) house, and from two others close by, 4 mice and 2 rats only were got during the same term, all of which were negative. Ferry Wharf, Sydney side, plague-rats had been taken as follows—1 21st February, 1 each 14th and 15th March, from Hart's Marine Café, which was installed on a floor above the extensive wharf itself; and on 16th March 1 carcase in which plague was identified (*M. rattus*) was found behind the wainscoting of the women's lavatory, No. 5 jetty, which was being torn down in course of alterations to effect rat proofing, which were being carried out by the Harbour Commissioners, the owners of the property. This was the lavatory visited by the patient on the 19th (or 20th) March.

Connected Cases.—None.

Case 38 (LL, d).

Summary.—W.G., m., æt. 68, married, a bricklayer. Residence, Bourke-street, Waterloo (Zetland); employment, *see* Movements before Attack. Notified by Dr. Langton, 28th March, 5 p.m. After death body removed to public mortuary; *post-mortem* examination conducted by the Second Government Medical Officer for Sydney, and attended by temporary Assistant Medical Officer, Dr. C. S. Willis, M.B., D.P.H. Septicæmic form; slight secondary glandular enlargement at various points.

Movements before Attack.—From 11th to 16th March, worked at a certain shop in King-street, City, which stands a few doors above Law's hotel (*see* Case 35); 17th (Sunday) and 18th, stayed at home, or looked for work; 19th, began work at R. Reid's, warehouseman, York-street, City; continued till attacked.

Attack.—22nd March, sudden, while at work, towards 5 p.m., vomiting and headache; the vomiting continued till death. 26th, first seen by a medical man, when he had severe headache, T. 102°, pain in right groin. 27th, same symptoms. Was next seen 28th, 4 p.m., immediately after death, when the medical man thought he could feel an enlarged gland in the right groin. *Post mortem.*—Well nourished, punctiform hæmorrhages on inner aspect of thighs, cirrhotic liver, catarrh of the stomach, chronic disease of both kidneys; intestines and spleen normal; submucous hæmorrhages in stomach; a slightly enlarged gland could be felt beneath the right jaw, and another in the right femoral region; they were apparently normal on section, and free from paradenitic effusion; the latter, together with portions of spleen and liver, on preparation of films, cultures, and inoculation, proved positive.

Residence.—A detached brick cottage, one storey, 6 rooms, connected with sewers, in good sanitary state and clean; several stables in the neighbourhood at back.

Employment.—The shop in King-street at which he worked stood near Law's hotel, and in an infected neighbourhood.

Rats.—Residence and neighbourhood, no signs; no infection in the few it was possible to collect. Employment, some traces of past infestation at King-street, but no carcases were found, nor was there any history of dead rats; the warehouse in York-street on examination was found to be in excellent order, and to offer very slight signs of presence of rats (hardly of infestation) on one or two floors only; it was said that the whole stock had recently been overhauled, and that no rats were then found.

Connected Cases.—Patient's son (Case 40); see account of the Zetland group in the text.

CASE 39 (MM).

Summary.—E.W.E., m., æt. 18, single, labourer. Residence, 59, Woolcott-street, Darlinghurst; employment, Patent Asphaltum Company, foot of Druitt-street, City (Darling Harbour). Notified by Dr. Gleddon, 9th April, 12·30 p.m.; visited (C.S.W.), 1·45 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 4th June; duration, 59 days. Left femoral bubo; films and culture, positive. Lesions, a minute abrasion on the front of chin.

Movements before Attack.—Was employed for the company at the Exhibition Building, Prince Alfred Park, but on 4th, 5th, and 6th April, in a shed on Druitt-street wharf, mixing materials, and in and out of the store mentioned below.

Attack.—7th April, sudden, 1·30 p.m.; giddiness, headache; first felt pain in the groin at 8 p.m. same day; no sleep. 8th, made a good breakfast and went to work; noticed swelling in the groin at 10 a.m.; was obliged to cease work at mid-day.

Residence.—A boarding-house kept by patient's mother, in fair general state.

Employment.—Outside; but occasionally entered the small office and store for material.

Rats.—At residence, no signs of infestation. At employment, the Exhibition Building presented nothing suspicious; at the office and store, Druitt-street, 1 *M. rattus* was taken on each of the days, 6th and 10th April, in both of which plague was identified, and it was ascertained that several dead rats had been removed from the same premises and destroyed at some time a little earlier; subsequently it turned out that the whole neighbourhood was greatly infested, and plague-rats were identified at several neighbouring places.

Connected Cases.—None.

CASE 40 (NN, d).

Summary.—F.D.G., m., æt. 26, single, plumber. Was associated with W.G. (Case 38). Residence, Bourke-street, Waterloo (Zetland); employment, had work on day of attack only, at Union Iron Foundry, George-street, Redfern. Notified by self, 9th April, 9·15 a.m.; examined (C.S.W.), 10·30 a.m.; admitted to Coast Hospital, 4 p.m.; died, 15th April; duration, 7 days. Right femoral bubo; films negative, culture positive; lesions, traces of innumerable fleas.

Movements before Attack.—With his father during illness; attended funeral 30th April; was out of work, and occupied the rest of the time in following up his late father's tracks with a view to contributing to identification of the place of his infection.

Attack.—8th April, sudden, 6 p.m. On rising from the tea-table, staggered; felt pain in the right groin, and had to be assisted to bed immediately; rigors, headache, backache, and a sleepless night followed. 9th, no vomiting; wandering mind; about mid-day lapsed into unconciousness. 10th, conscious, but exhibited marked apathy.

Residence.—See Case 38.

Rats.—Search of residence and neighbourhood, including stables near by, between 30th March and 12th April, furnished evidence of no particular infestation, 1 *M. decumanus* and 3 mice having been taken at the residence, and 5 rats and 3 mice from the neighbourhood, all of which were free from infection. Large numbers of traps were set, and careful inquiries made.

Connected Cases.—W.G. (Case 38); see account of the Zetland group in the text.

CASE 41 (OO).

Summary.—L.G.M., m., æt. 21, single, clerk. Residence, 19, Frederick-street, Ashfield; employment, Dawbarn & Co., importers, Vickery's Chambers, Pitt street, City. Notified by Dr. Allen, 11th April, 12·30 p.m.; visited (C.S.W.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 4th June; duration, 55 days. Right femoral bubo; films and culture (11th), negative; 12th, culture of contents of bubo, positive; contents of pustule on calf of leg, positive. Lesions, a few old abrasions; on the calf of the leg there was a pustule of moderate size.

Movements before Attack.—Constantly employed at the importers; visited the Custom House and the Wharfage Office occasionally.

Attack.—9th April, went to bed well; 10th, awoke with a sick headache and pain in the right groin; went to work and continued all day; about 3 p.m. noticed a tender swelling in the groin. The same symptoms continued till examination, 11th April, when his T. was 103·6°, P. 100.

Residence.—Detached brick house, 9 rooms, connected with sewers; good sanitary state; no stables near.

Employment.—Three rooms in a large office building: samples of crockery, glucose, a few tins of grease, &c. General state, satisfactory.

Rats.—At residence, no signs. At employment, patient said he had seen 3 or more dead rats in the store-rooms; and on 9th April another. These were not submitted, as poison had been laid. In one of the rooms was a considerable quantity of rat-dung. Poison had been regularly laid in the basement for two months previously, but none on upper floors, except by patient, as noted above; however, there were few signs of general infestation.

Connected Cases.—None.

CASE 42 (PP, d).

Summary.—E.J.O'B., f., æt. 27, married, laundress. Residence, 123, Eveleigh-street, Redfern; employment, Federal Laundry, corner of William and Dowling streets, Darlinghurst, City. Notified by Dr. Langton, 17th April, 4·30 p.m.; visited (C.S.W.) 5·15 p.m.; admitted to Coast Hospital, 10 p.m.; died, 27th May; duration, 76 days. Left femoral bubo; films and culture positive. Lesions, none found.

Movements before Attack.—Constantly employed, and went nowhere but between dwelling and employment.

Attack.—13th April, morning, gradual pain in left groin, headache and loss of appetite; at 7 p.m., rigors, vomiting, and diarrhœa, all of which continued during the three following days. Swelling in the groin was not noticed till pointed out to her (17th). In the course of the illness both eyes were invaded; one was destroyed, the other recovered. Towards the end she suffered from cerebral symptoms, attended with coma, which were markedly relieved by lumbar puncture and withdrawal of about 60 c.c. of cerebro spinal liquid. Films and cultures made with liver, spleen, and pus from the left femoral gland at the 76th day after attack, were all negative.

Residence.—A detached brick house, connected with sewers, in fair sanitary state.

Employment.—Was in very good order; concrete floors.

Rats.—At residence, traces of past infestation, and occupants said the house was infested not later than eight months ago; few rats in neighbourhood, and those trapped were negative. Employment, signs of present, but moderate infestation; a rat-hole within 8 feet of where patient stood at work; 3 rats and 3 mice taken, all negative. A full list of customers was obtained; none of the customers had been infected.

Connected Cases.—None.

Case 43 (QQ).

Summary.—F.W.P., m., æt. 12, schoolboy. Residence, 368, Sussex-street, Darling Harbour. School, Sussex-street Public School. Notified from Sydney Hospital, where he had applied for admission 16th April; visited (C.S.W.), 16th; admitted to Coast Hospital, 18th, 4 p.m.; discharged, 22nd May; duration, 39 days. Left inguinal bubo, and some enlargement of glands on the right side, as well as in both axillæ; films and culture from bubo (16th) negative; 17th, the same, film negative, culture positive; 19th, from an inflammatory lesion of the left shoulder, culture positive. Lesions, a wound in the left heel (inflicted while bathing) and 3 abrasions of left leg.

Movements before Attack.—Regularly at school; served in the restaurant kept by his parents; ran errands; played on vacant lot near dwelling.

Attack.—14th April, sudden, 7 p.m.; nausea, shivering, headache, giddiness, and a lump in the groin; did not immediately go to bed; 15th, same symptoms, but did not stay in bed; 16th, walked to Sydney Hospital.

Residence.—A brick house, used as a restaurant and dwelling, in fair general state and repair; connected with sewers.

School.—In perfectly good order.

Rats.—At dwelling, signs of present infestation, but no carcases found, nor any rats taken. The school was free from signs, and was rat-proof. The patient said he had seen dead rats (at some time) on a vacant allotment where he played. His residence stood in an infected neighbourhood, from which plague-rats had been taken during two or three earlier months; many wholesale produce stores near by.

Connected Cases.—None.

Case 44 (RR, d).

Summary.—P.J.O'D., m., æt. 28, single, shop-assistant. Residence, 11, Yelverton-street, St. Peters; employment, McCathie & Co, drapers, 199, Pitt-street, City. Notified by Dr. Chenhall, 11th May, 10·45 a.m.; visited (C.S.W.), 12·45 p.m.; admitted to Coast Hospital, 5·30 p.m.; died, 11th May; duration, 6 days. Right femoral bubo; films and cultures positive.

Movements before Attack.—Irregular; was at work, but drank.

Attack.—5th May, sudden, pain in right groin; 6th, felt weak and giddy, but worked; 7th and 8th, diarrhœa and vomiting, but still worked, supposing his illness to be due to drink; 9th, worked until 3 p.m., when he became unable to stand, &c. Right femoral bubo; films and culture positive.

Residence.—A detached weatherboard cottage in good sanitary state, connected with sewers, and clean; fleas abundant; no stables near.

Employment.—A large building in good order.

Rats.—At dwelling, no signs. At employment, no signs of infestation, but a carcase was found on the ground floor 14th May, which turned out to be plague-infected. A door to a lane at the back on this floor was ill-fitted, so that rats might wander in (compare Case 28; Hordern's drapery was close by McCathie's, and similar circumstances were noted in connection with it).

Connected Cases.—None.

Case 45 (SS).

Summary.—C.W.S., m., æt. 24, single, labourer. Residence, 118, Young-street, Annandale; employment, Edginton & Co., 207, Sussex-street, produce merchants. Was inoculated in 1900 (Haffkin). Notified by Dr. Fenton, 21st May, 4·10 p.m.; visited (C.S.W.), 5 p.m.; admitted to Coast Hospital, 22nd, mid-day; discharged, 20th June; duration, 33 days. Left femoral bubo; films and cultures positive; lesions, a few healed abrasions (said to be three weeks old) on left shin.

Movements before Attack.—Constantly employed, and hardly went elsewhere than between home and warehouse.

Attack.—19th May, sudden, at 6·50 p.m., chills and frontal headache, but was able to go to church same time; malaise, weakness, and general pains; slept well. 20th—At waking noticed a lump in the left groin, and a smaller one in the left axilla; remained in bed. 21st—Same symptoms. The axillary gland was probably chronically enlarged from other causes.

Residence.—A detached brick house in fair sanitary state, clean, connected with sewers; a stable not far away.

Employment.—A three-storey brick building and a small detached brick store, floors concreted, general state fair.

Rats.—At residence, no signs; at employment, abundant signs of infestation; 9 *M. rattus* and 4 mice trapped there were negative.

Connected Cases.—None.

Case No. 46 (TT).

Summary.—E.K.W., f., æt. 21, calico-bag maker, single. Residence, 35, Thomas-street, Marrickville; employment, Joyce Brothers & Co., Hay and Lackey streets, Darling Harbour, City; last attendance, 12·30 p.m., 24th December. Notified from Royal Prince Alfred Hospital, 31st December, 11 a.m.; visited (C.S.W.), mid-day; admitted to Coast Hospital, 1st January; discharged, 18th February, 1908; duration, 53 days. Left femoral bubo; films, cultures, and inoculation-test positive. Lesions of drainage area, many flea-bites on leg; there had also been slight injury to the thigh (see below).

Movements before Attack.—Lived at home; attended at her place of employment regularly till mid day, 24th December, when she left to attend a wedding at Petersham; 25th, remained at home; 26th, visited Stanwell Park (a long distance away in the country); 27th, at home.

Attack.—During the afternoon of the 27th received a kick on the left thigh, which was followed by a noticeable feeling of soreness; 28th, headache at waking, vomited during the day, and was slightly delirious; 29th, had medical advice; 30th, noticed some swelling on the thigh in the morning, which was tender, but not painful; was admitted to Prince Alfred Hospital, where a diagnosis of hernia led to incision of the swelling, which was then scraped; in the evening was again slightly delirious.

Residence.—A good brick cottage, semi-detached, in good repair and order; connected with sewers.

Employment.—Brick, two storeys, less than a year old; used as a store for jute bags (imported from India) and as a factory for calico flour-bags, &c. Said to have been built with special reference to exclusion of rats. These premises were in good order.

Rats.—Employment: The premises were in unusually good order, and were not rat infested; but in the course of search, 21 rats were caught, 5 within, 16 in a yard outside, the building, all of which were examined and were free from infection. There were no dead rats. Residence: There were no signs of infestation; no rats were found. It was said that none had ever been seen on the premises, and the occupant of the adjoining (semi-detached) house made a similar statement. Neighbourhood: Patient's house stood about 70 feet from Asprey's produce store, 154, Canterbury-road, Marrickville, where, in the course of search and cleansing of the neighbourhood, and in one only of the three stores used in the business, each of which measured about 50 x 30 feet, 12 rats were killed and 80 rats were found dead; 26 mice were also killed or found dead. Some of these carcases were too putrid for examination; but 44 rats and 24 mice were brought in, of which, 15 of rats were found to be infected with plague, as well as 6 of mice. Plague-infected rodents were also found at Nos. 95 (1 rat), and 103, New Canterbury road (3 rats and 1 mouse), and at 34, West-street, all of which were closely adjacent to Asprey's produce store, though on the other side of the road and in the municipality of Petersham; and, after further search, the infection clearly appeared to be limited to the narrow area thus indicated, of which Asprey's may be regarded as the centre. E.K.W. had not entered Asprey's, but during her return from evening walks had stood habitually, and for some minutes, outside the store, bidding her friends good night, and usually at a point where, as it happened, there was a rat-hole.

Connected Cases.—With the patient, none; but as regards the store, see Case 47.

CASE 47 (UU).

Summary.—J.H.K., m., æt. 21, cow-keeper, single. Residence, St. George's parade, Hurstville; employment, the same (he kept 5 cows); last attendance, 30th December, mid-day. Notified by Dr. O'Keefe, 3rd January, mid-day; visited (R.J.M.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 21st February, 1908; duration, 54 days. Left inguino-femoral bubo, the inguinal mass being the larger; films and culture, from material taken 3rd January from the inguinal mass, negative; culture made from the femoral gland at the Coast Hospital, referred for examination 6th January, positive. Lesions of drainage area, mark, possibly of old flea-bite, on the thigh; there was also an inflamed abrasion on the inner side of right patella, the result of injury received 24th December; microscopical examination, negative.

Movements before Attack.—Was constantly employed in milking his five cows and in distributing the milk to customers; visited the city occasionally, but not Darling Harbour.

Attack.—Sudden, 10 a.m., 29th December; shivering and headache; had risen in his usual health; later in the day abdominal and general pains, and a slightly tender swelling, about as big as a pea, appeared in the left groin; attended to business as usual during morning, lay about all afternoon. 30th, milked his cows and served his customers, but in the course of the day was obliged to take to bed, which he did not afterwards leave; delirious that night and on 31st; better 1st January, and on examination 3rd his condition was unaltered.

Residence.—Brick cottage, detached, 4 rooms, clean, in good order, pail closet; cow-bails littered with fodder, which harboured fleas, as experienced by cleansing staff.

Employment.—See residence.

Rats.—It was said that no rats had been seen for about a year past. Neither rats nor mice were discovered during cleansing; there were no signs of infestation of the premises, and no specimens could be found in the neighourhood; but fodder (namely, 1 bag of chaff, 2 of bran, and 3 of potatoes) was received from Asprey's store (see Case 46) on 24th December, and it was ascertained that these supplies had been taken from the third of Asprey's storerooms, which was that in which plague-infected rats and mice were identified.

Connected Cases.—With the patient, none; but this case was related to Case 46 through Asprey's infected store.

APPENDIX B.

TIME-RELATION between the onset of constitutional symptoms and observed disease of the gland in which the primary bubo occurred.

There were 47 cases; 7 had no bubo (primary plague pneumonia or septicæmia); in 7 others no sufficient history could be got. In the remaining 33 cases, pain in the gland was the first sign of illness in 8; pain in the gland was observed at the same time as constitutional symptoms in 8; and in 17 the gland was not affected, or was not observed by the patient to be affected, until some hours after constitutional symptoms had manifested themselves.

Pain in gland the first sign (8 cases):—

3. On waking, 6 a.m., observed a small tender swelling in groin; went to work; nausea prevented breakfast; to bed at noon.
4. On ceasing work, 8 p.m., noticed pain and swelling in groin; 9·30 p.m., had a rigor and vomited.
19. At work, during afternoon, noticed pain, and, 24 hours later, swelling in groin; no constitutional symptoms at any time; diagnosis—films and cultures, negative; inoculation, positive.
21. Pain in groin 9 p.m.; slept well; could eat no breakfast; and then the usual acuter symptoms set in.

27. At 4 p.m. first noticed pain in groin, aggravated by movement, headache, and a sleepless night followed.
30. On waking, pain and tenderness in groin; constitutional symptoms began 60 hours later with a sudden rigor.
36. Afternoon, having lifted a heavy box, felt sudden pain in groin, and found a lump; constitutional symptoms began in an hour or two.
44 (d). Felt pain in groin while at work; many hours after became weak and giddy; onset gradual. A drunkard.

Pain in gland and constitutional illness simultaneous (8 cases) :—
1. Retired well; awoke at usual time feeling ill, and with pain in groin; went to work, but obliged to cease in an hour or two.
2. Well, and at work all day; felt unusually tired at night and tenderness in groin; next morning too ill to rise.
26 (d). In afternoon sudden rigor, followed by fever; about the same time felt pain in groin.
34. To bed well; undisturbed night; roused at 7 a.m. by severe pains in head and back; at same time found tender swelling in groin.
40 (d). Worked all day; made a hearty tea; on rising from table vertigo and pain in groin; very acute illness began immediately.
41. To bed well; awoke at usual time with sick headache and pain in groin; to work; swelling appeared during afternoon.
42 (d). To bed well; shortly after rising at usual time, headache and pain in groin; at 7 p.m. sudden rigor and other acute symptoms.
43. Well all day; at 7 p.m. sudden attack—rigor, vertigo, headache, nausea, and a lump in groin observed same time.

Constitutional symptoms preceded pain in the gland by hours (17 cases) :—
10. Attack sudden, 4 p.m., vertigo, headache, pain in gland first felt 24 hours later.
12. Sudden, 5 a.m.; awoke by rigor, headache, pains in back and abdomen; about 15 hours.
13. At 7 a.m., after waking, headache and general pains; 48 hours.
15. At waking, headache, vomiting; about 12 hours.
17. Gradual attack; general malaise and pain, but continued at work; about 36 hours.
18. Sudden attack; at 4 p.m. a rigor; about 6 hours.
23. Sudden, at 7 p.m. a rigor; about 18 hours.
24 (d). Sudden, at 10·30 p.m. a rigor, headache, general pains; about 24 hours.
25. Sudden, at 6 a.m., after rising, headache and nausea; about 4 hours.
28. Sudden, during afternoon rigor, headache, too weak to stand upright; about 15 hours.
29. Sudden, at 9 p.m. rigor, headache, general pains; 12 hours.
32. Sudden, at 9·30 p m. rigor and headache, ; about 24 hours.
37 (d). Sudden, at 10 a.m. rigor and vertigo; about 24 hours
39. Sudden, at 1·30 p m. vertigo and headache; about 7 hours.
45. Sudden, 6·50 p.m. chills and frontal headache; about 12 hours.
46. Awoke with headache, then vomiting, later in day slight delirium; about 48 hours.
47. Sudden, at 10 a.m. rigor, headache, but worked; about 8 hours.

APPENDIX C.

ANALYSIS of the 47 Cases as to traced connection with plague-rats.

A.—Nos. 2 and 27 handled dead rats found on premises which yielded plague-rats.

B.—Nos. 1; 3, 4, 5, 10, 11, 12, 13 (which, with 2, constituted the Bank-lane group), 17; 18, 19, 21, 22 23, 25, 26 (which constituted the "Standard Hotel" group); 20, 24, 28, 37, 39, 41, 44 were employed or dwelt in houses which either yielded plague-rats before or after the date of attack, or yielded dead rats (credibly reported, or found in a state which estopped search for the bacillus) under circumstances which were deemed to warrant the ascription of plague as the cause of death.

C.—Of Nos. 6, 14, 29, 34, 35, 38, 43, 45, 46, it could only be said that they dwelt, or worked in, or visited neighbourhoods in which there was evidence that the epizoötic existed.

D.—In Nos. 30, 31, 32, 33, and 42, the source of infection could not be traced for want of information they included 2 vagrant men, a dressmaker (?), &c. Among them there was also 1 laundress who was ascertained not to have handled clothes which came from any place where a case of plague had occurred; but possible presence of plague-rats at some customer's house could not be excluded, of course.

E.—The remaining 8 cases arose in other ways, apart from plague-rats, or, as regards one or two, did so in all probability. Thus: Nos. 7, 8, and 9 constituted the Campbell-street group; 6 (primary plague pneumonia) has been reckoned under C above; 7 took the disease in the same form from him, 8 took it in septicæmic form from 7; while 9 lived in the same house as 8, in a neighbourhood where nothing suspicious was detected for many weeks afterwards, but may well have contracted his illness (bubonic form) independently, from being engaged in the same trade as 6. Then 15 and 16 constituted the Yule-street group, and were secondary to 5 (noticed under B above); 36 was secondary to 31 (Chippendale group), mentioned under D above; 40 was secondary to 38 (Zetland group), noted under C above; and as regards 15 and 16 it seems certain, as regards 36 and 40 very probable, that the infection was taken by them from the primaries of their respective groups. Lastly, 47 presented no novelty, but so clearly exemplifies communication of the infection by fodder which did not enclose a plague-rat, that it deserves special consideration. Detail of this, and of all the other cases, are fully given in Appendix A.

APPENDIX D.

Table showing the Species and Number of Infected Rats, and the Number of Cases in Man, reported during each week of the years 1903–7.

1903.

	Week ending—																																																				
	Jan.					Feb.				March.				April.				May.					June.				July.				Aug.					Sept.				Oct.					Nov.				Dec.				
	3	10	17	24	31	7	14	21	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	
M. decumanus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	2	1	..	2	66	3	..	2	1	..	..	..	1		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	86
M rattus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	..	..	1	..	..	..	9	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	26
M. musculus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	10	1	..	1	10	2	12	5	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	49
																																																					161
Attacks	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1904.

	Week ending—																																																					
	Jan.					Feb.				March.				April.					May.				June.				July.					Aug.				Sept.				Oct.					Nov.				Dec.					
	2	9	16	23	30	6	13	20	27	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	
M. decumanus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	26	..	..	9	1	17	4	3	7	1	1	..	..	1	22	..	..	..	2	1	1	1	..	5	1	3	..	..	1	..	..	..	..	..	..	..	..	108
M. rattus	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1	1	..	..	..	1	6	4	10	36	3	1	..	..	1	1	..	1	..	2	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	73
M. musculus	..	..	..	..	..	..	..	..	..	1	2	..	..	..	..	..	..	4	..	..	2	..	2	5	3	4	15	8	3	2	2	1	..	..	..	..	3	1	2	1	..	..	..	..	..	..	..	..	1	..	..	..	..	62
																																																						243
Attacks	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	2	1	..	1	..	1	1	..	..	1	..	..	..	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1905.

	Week ending—																																																			
	Jan.				Feb.				March.				April.					May.				June.				July.					Aug.				Sept.					Oct.				Nov.				Dec.					
	7	14	21	28	4	11	18	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	
M. decumanus	..	..	2	5	4	1	3	2	8	9	2	1	1	1	1	30	1	1	..	..	..	..	..	..	..	1	..	1	1	..	1	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	78
M. rattus	..	..	..	..	..	..	..	..	..	..	2	5	8	3	10	3	..	1	..	..	..	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	2	..	..	..	..	..	..	1	2	1	4	..	..	..	..	..	45
M. musculus	..	..	..	..	..	..	..	..	..	1	3	1	..	4	2	1	..	1	..	..	..	..	..	..	..	..	..	1	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	18
																																																					141
Attacks	..	..	..	..	..	..	..	..	..	1	..	1	..	4	1	2	2	2	1	2	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1906.

	Week ending—																																																			
	Jan.				Feb.				March.					April.				May.				June.					July.				Aug.				Sept.					Oct.				Nov.				Dec.					
	6	13	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	
M. decumanus	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	4	..	3	7	2	4	3	4	3	3	1	1	1	3	1	..	1	..	..	..	..	..	..	..	..	..	2	..	1	46
M. rattus	..	..	..	1	..	1	9	4	7	2	3	2	8	14	3	..	..	..	..	..	2	..	..	..	2	1	..	2	2	3	4	3	3	2	5	1	1	1	..	1	1	..	..	..	..	..	1	..	..	..	..	..	89
M. musculus	..	..	..	..	..	..	..	1	3	..	..	..	2	3	..	1	..	..	..	..	..	..	..	..	..	2	..	1	..	..	..	..	..	..	19	5	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	39
																																																					174
Attacks	..	..	..	..	..	..	..	..	..	3	4	..	..	..	..	..	..	..	1	..	..	1	..	..	4	2	1	2	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..

1907.

	Week ending—																																																			
	Jan.				Feb.				March.				April.					May.				June.				July.					Aug.				Sept.					Oct.				Nov.				Dec.					
	7	14	21	28	4	11	18	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	
M. decumanus	..	3	..	3	7	4	2	2	2	..	..	4	1	..	..	1	..	..	..	2	1	5	5	3	2	2	1	..	1	..	1	..	..	1	2	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	57
M. rattus	..	3	2	..	20	7	8	1	4	4	4	5	..	1	6	7	6	3	4	5	2	1	6	7	2	4	..	..	1	2	1	..	2	11	8	4	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	143
M. musculus	..	..	..	..	1	1	1	..	1	..	1	..	3	..	3	1	..	..	..	..	..	2	..	..	..	1	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	19
																																																					219
Attacks	1	1	5	7	..	6	6	2	3	2	3	2	..	2	3	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..

APPENDIX E.

(EXTRACT from the Report of the Board of Health on a Second Outbreak of Plague at Sydney, 1902, dated 31st July, 1903. By J. Ashburton Thompson, M.D., D.P.H., President.)

TWELVE CASES IN WHICH INFECTION WAS NOT TAKEN, IN ALL PROBABILITY, BY CASUAL CONTACT WITH DEPOSITED INFECTION.

262. The infection of plague is communicated to man by inoculation through the skin in the vast majority of cases. The proof has been well stated in the Report of the Plague Commission in India; it is " . . . . that primary buboes practically always develop in connection with lymphatics which originate in the skin . . . . ." The constant preponderance of "inguinal" or "groin" buboes over others, was also shown in the same paper to stand in relation to the larger area of skin which drains through the lymphatic glands of the groin. Analysis of returns, which represented 5,442 cases of bubonic plague, showed that the ratio in which buboes occurred in the lymphatic glands of the head and neck, the axilla, and the groin respectively, was nearly the same as the ratio which the skin-areas draining through the lymphatics of those regions bear to each other.

263. The proportion in which groin buboes are met with always preponderates over that in which the buboes occur in other regions of the body; this was very early observed among Eastern races who habitually go barefoot. Before long, however, the same preponderance was noticed among Europeans (though in small number) who did not go barefoot; but the hint thus given seems to have been overlooked, and (perhaps in consequence) assumed infectiveness of ground-surfaces became a prominent feature in writings on the ætiology of plague. But at Sydney, in 1900, we were able to show that in no less than 73 per cent. of the 286 cases in which buboes were exhibited, the latter were found in the groin, although all the patients referred to were white, clothed in European fashion, and invariably shod during the day (Report, 1900, p. 40). The validity of the banal explanation of the preponderance of groin buboes thus seemed to be rendered more than doubtful.

264. But I had pointed out in the same Report that the infection of plague was received by man, for the most part, within houses, which seems also to have been noticed in India (Plague Commission in India, July, 1901, Report, p. 101). Now, if the infection be usually received by man within houses, the objection raised above to the banal explanation of the preponderance of groin buboes must be revised, for there is a time of day when nearly all people, whites as well as others, go barefoot, namely, when they are going to bed or rising from it; at that time, therefore, infectious material deposited on floors, carpets, &c., by rats (or otherwise) would be more likely to come in contact with the unprotected skin of the feet than with that of any other part of the body. So that, although conjunction between a recent breach of the epithelium and deposited infection in the requisite state of activity cannot often happen, here is the opportunity for it, at all events; and plague was not so frequently contracted by our people in either epidemic but that possibly those persons who exhibited groin buboes might have received the infection in that way. Let us try, then, to ascertain what the fact was: Does the record contain any cases in which infection resulting in groin buboes was, probably, not contracted by casual contact with deposited infection of the unprotected skin of the lower extremities? If it turn out that it does, the hypothesis under examination will be very greatly weakened; must, indeed, be discarded as an explanation of epidemic bubonic plague.

265. Among the 139 cases which constituted the epidemic, there were 106 in which buboes occurred in the groin. But it is necessary to speak more exactly. Our present concern must be with primary buboes, since these alone indicate the region of skin through which the virus entered; and, in order to leave no room for possible confusion between primary buboes and secondary glandular swellings, it is desirable to take into account only those cases in which the groin bubo was solitary. Then the expression "groin bubo" is loose. A bubo in one of the oblique set of inguinal glands indicates infection through the skin of the lower part of the trunk. Buboes in one of the vertical set of femoral glands alone indicate infection through the skin of the feet, or of other part of the lower extremity. An examination intended to discover whether there were buboes betokening infection through the skin of the lower extremity must, therefore, be limited to cases which exhibited *solitary* buboes in one or other gland of the *femoral* chain.

266. The total number of such cases was 60, but the majority are not available for the present purpose. Thus the place at which the infection was taken could not be determined in 16 of them; either the inquiries made failed to reveal any clue to it, or else the evidence for infection at home and at work seemed equally cogent. These 16 must be thrown out, therefore, for they (or some of them) may have been infected at their place of residence, where they were admittedly exposed to the risk ascribed to bare feet which is now under investigation. In 25 other cases it was considered that the patient did receive the infection at his place of residence, so that these, too, must be thrown out for the reason just given. In 3 others the place of employment probably was the place of infection, but the details left room for some slight doubt; these are excluded by way of precaution. Three more were Chinese, concerning whom either information of the required kind could not be got at all, or it was untrustworthy. Lastly, one was a woman whose movements could not be traced. So that 48 of the 60 have to be discarded. There remain 12 patients who had solitary femoral buboes, and who are confidently adjudged to have received the infection away from home (while at work, in all but one case), and, therefore, while fully clothed.

267. Most of the twelve cases have been already referred to at greater or less length; their serial numbers are therefore given, together with a reference to the paragraphs in which the necessary particulars concerning them may be found: 1 (par. 77), 14 (par. 92), 18 (par. 212), 21 (par. 211), 34 (par. 217), 49 (par. 134), 70 (par. 218), 84, 88, 93, 125, 129 (par. 219). The following are details of the four cases which have not previously been described:—

Case 84.—M., æt 39, a tailor; attacked, March 26, at midday, while at work; discharged, May 24; place of employment, 267 Pitt-street. From under the floor of the room in which the patient worked as a presser nine carcases were removed; many others were found under the floors of adjacent rooms, as well as large quantities of rats' dung, nests, rags, paper, and seeds (from a florist's). Place of residence, Strathfield, a suburb 7 miles away, which has harboured no other case of plague at any time; the house was in very good order, and entirely free from all traces of rats.

Case 88.—M., æt. 55, carpenter; attacked, March 27, morning; discharged, April 26; place of employment, Union S.S. Co.'s wharf, Darling Harbour, which was one of the infected line. Residence, Leichhardt, a suburb about 3 miles away, which had yielded no indigenous cases; the house was in good order, clean, and entirely free from all traces of infestation.

Case 93.—F., æt. 27, sempstress; attacked, April 3; discharged, May 24; place of employment, an upholsterer's, 137 to 141 Castlereagh-street. There were abundant signs of infestation with rats everywhere, but no carcases were found; dead rats had been seen six weeks earlier when, it was alleged, poison had been laid. Residence, Marrickville, a suburb about 4 miles away, which had at no time harboured any other case; the house was in good order, and entirely free from all traces of infestation.

Case 125.—M., æt. 54, carman; attacked, May 11, midday; died, May 16; place of employment, Gray's stables, Elizabeth-street, Waterloo, which were infested with rats, and from which a plague-rat had been taken on April 26; another plague rat was taken at other stables near by on April 21. Residence, 151 Bullanaming-street, in fair order; it was said that no rats had been seen there, and there were no traces of infestation; no indigenous case had occurred anywhere near the house, but the further neighbourhood of it was not free from suspicion.

268. Of these patients 8 inhabited houses in neighbourhoods which were distant or even remote from the infected area, and which were at all times free from suspicion of infection with plague (yielded neither indigenous cases, nor plague-rats); and while, on the one hand, 11 of the residences bore no traces whatever of infestation with rats (the twelfth alone having exhibited some slight signs of infestation), on the other hand the places at which the patients were employed (including one who had merely visited Her Majesty's Theatre) were badly infested, and had yielded dead rats in number in ten instances at least.

269. It is certain that these persons all fell into danger at their place of employment, and apparent that they were not infected at home. At their employment they were fully clothed; their lower extremities were protected by boots, socks, or stockings, and trousers or petticoats, while their hands, arms, necks, faces, and in some cases their chests too, no doubt, were uncovered, exposed, and in no way protected from casual contact with deposited infection: and, therefore, they should, *ex hypothesi*, have exhibited cervical or axillary buboes. In fact, however, they none of them did so. They were all of them inoculated in one or other lower extremity—in that very area of skin which, beyond all doubt, was well protected from casual contact with deposited infection.

270. I am unable to imagine any plausible explanation of the inoculation of these 12 persons in the lower extremity, which does not include some means of communication between them and plague-rats which is complete in itself, endowed with locomotive powers, attracted to man by instinct, and more likely to reach this than any other part of the body. These requirements betoken an insect, and the insect which best meets them appears to me to be the flea.

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J. ASHBURTON THOMPSON.

APPENDIX F.

PAPERS on the Defence of India from Plague. Reprinted from the Transactions of the Royal Society of Medicine, Epidemiological Section, 2 December, 1907. Dr. Newsholme, President of the Section, in the Chair.

On the Present Methods of Combating the Plague.

BY W. M. HAFFKINE, C.I.E.

I.

I SHALL begin my review by briefly enumerating the measures suggested for stamping out the plague or preventing its importation. These measures deal either with man, with inanimate objects, or with the lower animals. The first category of measures comprises:—

(1) Discovery and notification of persons attacked with the disease.
(2) Isolation of the attacked.
(3) Certain precautions with regard to the disposal of the dead.
(4) Segregation of those who have come in contact with the sick or dead.
(5) Institution of cordons round infected areas.
(6) A less drastic and less thorough plan than the last mentioned, viz., placing in quarantine arrivals from infected places, detaining the sick and suspected, and letting the rest free after a time of observation; or
(7) A still less rigorous measure, which is merely to examine travellers, isolate the sick and suspected, and let the others free under a system of surveillance.

The following may, I think, be said in regard to this group of measures:—

The part played by man in the causation of plague seems, on the whole, subordinate to that of other agents. Thus, when the plague first broke out in Bombay, in the summer of 1896, it remained for a considerable time confined to a quarter called Mandvi. The mass of people there are day labourers, working outside their quarter. Though they spent the day in close communion with many other people, cases continued to occur among the Mandvi labourers alone and in their families, and only subsequently and gradually appeared in other quarters. Since that year Bombay has had eleven consecutive outbreaks. Every year the epidemic lasts for some months and becomes relatively quiescent for the rest of the time, but the recrudescence begins approximately in the same locality, and the same events are more or less uniformly repeated.

Subsequent to the appearance of plague in Bombay, a township called Kirkee, near Poona, became infected, and the disease broke out among the native followers of the Royal Artillery. The men and their families lived on a spot somewhat away from the rest of the people, but spent the day at work in the batteries. Throughout the epidemic the batteries remained free from disease, while the followers suffered heavily; and they suffered practically in the same proportion as their womenfolk and children, who did not leave their homes. Similar facts were observed on the Colaba peninsula, in Bombay, among men who, in the daytime, were at work in the Army and Navy Co-operative Stores, and at the Gun Carriage Factory, and spent the night with their families. The other people in the Army and Navy Stores and at the Carriage Factory remained free, but the Colaba men suffered equally with their families.

Further, on many occasions it has been observed that plague first started in a town by attacking persons who had not been away and among whom no history of contact with people from an infected place could be discovered; and, *vice versâ*, in every country invaded by the disease, there are districts, towns, or villages in which, though the people are in constant communication with infected places, and cases of plague are constantly imported into them, the disease gets no footing and the locality remains exempt from invasion.

The proposition illustrated by these facts, viz., that man does not play a predominant part in the conveyance of plague, is supported also by other observations. In 1897 a plague hospital was established in the vast premises of the old Government House at Parel, in Bombay, and a number of patients soon gathered there. In order to minimise the objections to hospital treatment, families were allowed, if they so wished, to accompany their patients, stay at the hospital, and attend on them. The officers in charge soon noticed that when a family took advantage of this permission to dwell in the midst of numerous plague patients, its members were safe from disease; but when they remained in their own home, although the only case of plague had been removed, other cases often followed. In the same way, very rarely has it been seen that any of the permanent attendants in plague hospitals have taken the disease. Pneumonic cases alone have proved dangerous in this respect.

The observations above quoted warrant, I believe, the following propositions, now more or less generally recognised, viz., that (1) plague is what has been termed, in a general sense, a disease of locality; (2) that it is contracted principally at night; and (3) that the part which man plays as direct agent in its propagation is a more or less subordinate one. This being so, the measures taken with regard to man, even when carried to perfection, can influence the propagation of plague only to the same proportionately limited extent. In the vast majority of cases events have conformed with this conclusion, in that precautions taken against the importation or the spread of plague by man have failed to secure the desired end. It must, however, be stated that these precautions can rarely, if ever, be carried to perfection. Their application is fraught with great difficulties, and is often impracticable. This is due to the impossibility of enlisting the self-sacrificing co operation of individuals, to the first cases being rarely recognised, to the reluctance of those falling ill to deliver themselves into the hands of strangers and officials, to the measures of prevention hurting trade and numerous private interests, and to the consequent wholesale evasion of prescribed rules. The time, therefore, arrives when the measures directed against man are relaxed or dropped, and efforts are chiefly applied to inanimate objects.

II.

This part of the programme seems lighter of accomplishment. The list of measures, within an area infected, comprises, in this case, destruction or disinfection of houses, furniture, clothing, bedding, carriages, goods, warehouses, grain and other stores, garbage, drains and streets. Outside the infected area the measures consist in the refusal to admit carts, trains, and ships with goods from infected places; or in the refusal to admit only certain goods; or in mere inspection of trains, carts, and ships, and some procedure by which these, and the goods they convey, as well as the belongings of travellers, are sought to be rendered harmless. All these measures are intended for the avoidance or destruction of plague germs which may possibly exist in the objects concerned.

Plague bacilli have, however, been very carefully looked for, but so far have not been discovered in the earth, on the walls or floors of houses, or on any inanimate object, unless they were quite obviously and recently soiled by the products of a plague patient. I am not, moreover, aware of a single instance in which the extension of this disease by means of goods of an inanimate nature has been conclusively demonstrated, though linen, clothing, handkerchiefs, and other personal belongings of a sufferer from pneumonic plague, if soiled with his sputum or nasal discharge, must be dangerous for a certain, possibly long, period of time. Further, the microbe of plague is not a resistent organism. From the first it was seen that under ordinary circumstances it was easily killed by disinfectants, and that exceptional conditions are required for that microbe to resist and preserve its vitality. Under these circumstances the following conclusion might seem justifiable: If inanimate objects are important carriers of plague, disinfection should generally be an effective check to its spread, and on this presumption the above measures were devised.

According to numerous observations, however, made by health authorities, a house, its furniture, all the belongings of the inmates, and the inmates themselves may be washed and disinfected repeatedly, and yet cases of plague may occur subsequent to each disinfection, if people are allowed to stay in that house. Though general statements to this effect have been made by earnest observers, I am not aware of a precise demonstration of a case in which disinfection arrested the development of an epidemic of plague.

The above theoretical considerations must be supplemented by the following remarks of a practical nature: The expense and the difficulties of destroying or thoroughly disinfecting houses, goods, and other property over a vast area are very great, and the agency for properly carrying out such measures is not available or is not forthcoming.

The enormous bulk of merchandise conveyed nowadays by rail and ship admits of no process which would answer to elementary requirements of disinfection; and the opposition and hostility of vast numbers of people, whose interests are interfered with by these measures, can only be estimated when the task is actually undertaken.

III.

I come to the measures relating to the lower animals. These are :—

(1) Destruction or keeping away of rats by poisoning, trapping, tar and sulphuric acid mixture, or through the agency of the domestic cat.
(2) Improvements in towns and villages, with a view of reducing or keeping out the rat population, viz., structural alterations of dwellings, warehouses, and grain stores, demolition of insanitary buildings, introduction or improvement of conservancy arrangements, prompt disposal of garbage, periodical inspection of stores, paving and draining of streets, and certain other measures.
(3) Destruction and dispersion of fleas by petroleum or other insecticides.
(4) Fumigation of houses as a temporary protection against rats and fleas.
(5) Obligation on ships from infected regions to anchor away from the shore ; or,
(6) Provision of mechanical arrangements for preventing the landing of rats along mooring cables and gangways ; and
(7) Fumigation of ships arriving with plague patients or plague rats on board.

The measures have, therefore, for their object, and, I believe, rightly so, the rat and the flea, described by Rothschild under the name of *Pulex cheopis ;* but epizoötics of plague break out also among squirrels, tarbagans, guinea-pigs, monkeys, mice, kangaroos in Australia, and some other animals, which contribute to keeping the disease alive.

Measures for the destruction of rats were applied in India at the beginning of the epidemic, viz., in 1896, by Professor W. J. Simpson, then Health Officer of Calcutta, and have been carried on also in the subsequent outbreaks in many places. A new impulse has been given to them by the labours of the recent Plague Commission in Bombay. But nowhere, possibly, has the effect of these measures been more carefully gone into than in Sydney, under the direction of Dr. Ashburton Thompson. The campaign against rats and fleas is the most rational and the best founded of all the procedures suggested for stamping out the plague, for outside the human body in animals alone have plague microbes been actually seen so far in nature. It is, however, essential to estimate the extent to which this is a promising direction. Various factors, such as increase of the human population, destruction or planting of forests, occupation of waste lands, building of canals, introduction of new animals and plants, and a variety of other circumstances bring about, in the course of time, important changes in the flora and fauna around us. I might quote, as relatively modern instances, the disappearance of wolves from Great Britain, or the practical extinction of the bison, or of the black rat, from these islands and the continent of Europe, and a few others. These changes have taken place gradually, and in such long periods of time, that the exact causes which have brought them about are unknown.

Up to quite recently it would have been impossible to name a single instance of a result of this kind having been effected in a short time by steps of an administrative character, or even by the resolve of a whole population. From time immemorial man has had to put up with the presence in his proximity of animals and plants interfering with, and devastating, his crops—locusts, field mice, spermophiles, campagnols, phylloxera, mildew, rabbits in Australia, and so on. The power of adaptation and reproduction with which nature has endowed many of these animals and plants generally triumphs over the deliberate efforts of man when the surrounding circumstances are favourable to their multiplication. Still the problem is not wholly impossible.

The recent successful instances, to which I have alluded, are the campaigns against mosquitoes in Ismailia, in Klang and Port Swettenham, in the Panama Canal zone, and in a certain number of other places at which it has been found possible to alter, in a short time, the surrounding conditions so as to render the propagation of these insects impossible. These examples are a grand and splendid lesson to the world, but a lesson which, it must be acknowledged, is, in many cases, difficult, and in others, impossible of imitation.

The observations made by the Chief Medical Officer of New South Wales are of interest in this connection. I have in view his carefully organised campaign against rats in Sydney, with the object of protecting from plague a white population of a high standard of intelligence and education. During that campaign Dr. Ashburton Thompson found that the gross returns of rats and mice caught and destroyed, week by week, were nearly uniform, and that there was thus no evidence that the slaughter produced such an impression on the general horde as would have rendered collection progressively more difficult. The opinion he came to was that extermination of rats in any large area by poisoning and trapping was practically impossible, and that the plan of spreading among them an artificial epizoötic by means of Dr. Danysz's rat virus failed on account of that virus rapidly losing its virulence. Regarding this latter point, one cannot forget that India has now had, in the plague bacillus, eleven years' experience of a most devastating virus for these animals, and as yet there is no sign that this involuntary experiment has rid the country of their presence.

The observations coming from Japan, where determined efforts have been made to destroy rats are as little encouraging. The facts published in June of last year were to the effect that in Tokyo alone 4,800,000 of these animals had been killed, but the slaughter seemed only to have prepared more favourable conditions for the multiplication of the survivors.

Dr. Ashburton Thompson's experience, in regard to facilities given by householders in Sydney for the detection of plague-rats, was identical with that gained in India. He found that the people were reluctant to admit to their premises rat-catchers and other strangers bent on that task, and that the information supplied by the inhabitants, as well as that gathered by the professional men specially appointed for the purpose, was so scant as to be barely sufficient to indicate the presence of infection in a locality, but not to gauge its severity. Though, therefore, the measures against rats, either by extermination or by change in the construction of cities and villages, are a most important item in an anti-plague campaign, the question whether any noticeable impression can be made on the epidemic by these measures within the length of a generation, or even in a longer period, is a matter of great uncertainty. Even the destruction of rats on ships alone, if imposed as a general measure, would cause a dislocation of traffic and an outcry formidable to face. The result is that every day plague is imported, though, fortunately, it does not spread into one part or other of the maritime countries of the world.

IV.

IV.

The above analysis of the facts connected with the problem of stamping out the plague leaves little room for surprise when it is seen that, although in many places reached by the plague, the latter, as I have just mentioned, does not take root and dies out, in others, where it finds a congenial field for its propagation, the attempts at eradicating it prove unavailing. Thus often ends in disappointment what may be termed the *first stage* of the struggle against that disease, namely, the efforts of stamping or keeping it out. This result becomes apparent to the population, who are the sufferers, long before the medical or sanitary authority makes up its mind to acknowledge defeat; and when they first become aware of it the people fly in a stampede in all directions. For, although bare figures of the plague death-rate impress different people differently, there can be no doubt as to a plague actuality being a terrifying event. It takes time to get used and, so to say, reconciled to it. European countries must still have some recollection of their own experience of the matter. The people therefore flee and seek shelter in other towns. But their means of livelihood are left behind in the old place: nowhere is employment and sustenance ready for new and sudden arrivals. After a period of suffering and hardships the fugitives return in search of work to the old place, and resign themselves to the inevitable.

I have referred, however, to the fact that when plague first occurs in a given quarter of a city it remains confined to that quarter for a certain time. There is thus no necessity for going far afield. In the Himalayas and the plains of India the villagers, whenever possible, go out a mile or two from their houses and live under trees or in open fields. Often, however the disease breaks out in the mountains in severe winter, and in the plains during the season of rains. To remain then in the open or in rapidly put-up shelters, with a scanty provision of clothing and bedding, with the difficulties in preparing food, protecting property, caring for and sheltering the small children and the aged, becomes an untold hardship. In towns, on the other hand, unoccupied land is scarce. The people, in fair weather, go into such open spaces and public squares as are available. A water supply, conservancy arrangements, police administration, fire prevention, patrolling of abandoned houses and property, depôts for boxes and bundles, and a number of other arrangements become necessary. With this, the deprivation of ordinary comforts of a settled home is felt so keenly that only families in whose midst cases of plague have already occurred avail themselves of these facilities. The others remain at their homes and furnish material for the continuance of the epidemic. The plan of abandoning the affected locality, for shorter or longer periods, may perhaps be termed a *second stage* in a campaign against the plague.

To whatever extent that plan is feasible, to that extent the effect of it is beneficial. It is the limited range of it and the innumerable complications which it brings in its train that finally lead the administration and the people to resort to what always seemed to me the *ultimate method* of combating the bubonic plague in the areas in which it becomes endemic, viz., that of conferring on the population immunity from the disease by means of an artificial treatment.

V.

I imagine that in this Section of the Royal Society of Medicine it would be out of place to enter into the bacteriological aspect of the anti-plague inoculation, to axamine the various views from which the subject might be approached and solved, and the advantages and difficulties of each. For the purposes of the present deliberations it may, perhaps, be sufficient to enumerate the salient points of the matter, as ascertained in India in the last ten years. These are :—

(1) That in a native of that country, who is more susceptible to the disease than Africans, Europeans, and some other races, the inoculation now in force in India reduces the liability to attack to less than one-third of what it is in a non-inoculated Indian.

(2) That in the one-third of cases which still occur, the recovery rate is at least double that in the non-inoculated attacked, the ultimate result being a reduction of the plague mortality by some 85 per cent. of what it is in inoculated Indians.

(3) That in an inoculated European an attack of plague, if it subsequently occurs, has so far always ended in recovery.

(4) That the inoculation is applicable to persons already infected and incubating the plague, and prevents the appearance of symptoms, or else mitigates the attack, a fact which disclosed a basis for the bacterio-therapeutic treatment of disease.

(5) That in natives of India the degree of immunity conferred by this inoculation, though gradually vanishing, seems to last during several outbreaks of plague ; and that

(6) In Europeans the effect has not yet been seen to disappear in the space of time, since 1897, that this inoculation has been under study.

I now proceed to matters which concern the epidemiological aspect of the question, viz., the place which experience has indicated should be assigned to this plan of defence in plague-stricken provinces.

His Majesty's letter on the plague, addressed to the Governor-General of India on 13th August last, and Lord Minto's communication to the heads of local governments and administrations, have brought about a renewal of efforts to bring down the plague mortality. Lord Minto's letter points out that many expensive and harrassing operations carried on in the past may be safely abandonod, and expresses the hope that, with the assistance of the people themselves, some distinct advance will now be made towards bringing the ravages of the pestilence under control. Consequently, in most places fresh campaigns have been undertaken and organised in the light of the teaching gained during the past decade.

The Province which has had most of this unhappy experience is the Bombay Presidency, where the disease appeared first, viz., in 1896. The result of this expence may, I think, be gauged from the following official utterances: On 7th October last, the Hon. Mr. Muir Mackenzie, then Acting Governor of that Presidency, in a speech addressed to the Municipal Corporation of Satara, summarised the mutual position of the two pincipal measures on which the Bombay Government have learned to rely in the struggle against the plague. "Evacuation," he said, "is no doubt effective *quantum valeat.* But think of its drawbacks. I doubt if it would have been possible at all during the torrential rains of July and early

August. If managed, think of the miserable discomfort, the risk of chills and fever; and, at its best, what a dislocation of business, what a disturbance of home, what expense, what discomfort, is entailed by evacuation. Evacuation will not cure the stoppage of business, the closing of schools of which you complain. But if inoculation were general none of you need stir—your business would continue, your schools would be full, everything would be as before. I can fancy that in the old days small-pox may have entailed the same miseries as plague does now—fleeing the town, the runaways carrying infection; deserting the home only to catch the disease on daring to re-enter it. Now people, being vaccinated, are hardly disturbed when small-pox breaks out. Let it be the same with plague. Be inoculated at the first sign, and so obviate disturbance of the domestic and educational and business avocations of yourselves and your children."

Sir George Sydenham Clarke took over office as Governor of Bombay a few weeks ago, and on 12th November addressed to the vernacular newspapers a letter of which some telegraphic information has reached this country. He emphasised the heavy responsibility which rested upon the papers of using their influence with the natives to prevent the spread of the scourge. He acknowledged that if the people were unwilling to destroy the rats which were the vehicles of the disease, their feelings must be respected, and he therefore urged that recourse should be had to universal inoculation, which, he stated, was the easiest and most certain method of prevention.

The experience gained in the Punjab (the other great Province of India ravaged by the plague) has been stated in a memorandum which the local government addressed to the Government of India on 30th June, 1902, after five years of the application of various anti-plague measures. According to this statement *segregation of patients and "contacts,"* under the conditions which are essential to the success of that measure, is entirely out of the question, and intercourse between infected and uninfected places is in most cases quite unrestricted; *evacuation* is not a procedure which can be of assistance in checking the extension of plague from one locality to another; *disinfection* cannot be relied upon as a practical measure for the arrest of the epidemic; and there remains only *inoculation* with the plague prophylactic, and its benefits the Government declares, are so generally understood in the Punjab that a large proportion of the population of the infected districts can, without much difficulty, be induced to submit to the operation.

The part of India now exposed more dangerously than all the others is the United Provinces of Agra and Oudh. These provinces have at present, as head of the administration, the able civilian who, in 1898-1900, accompanied and took part in the investigations of the Indian Plague Commission, and had an opportunity of making himself closely acquainted with the working and the results of the various plans tested for combating the plague. In publishing, in the beginning of September last, His Majesty's and the Governor-General's letters on the plague, Sir John Hewett, the Lieutenant-Governor, issued a detailed plan, approved by the Government of India, of organising a special service to carry on inoculation when plague reappeared. The poor, who cannot afford to lose their earnings during the day or two of rest desirable after inoculation, are to be given assistance up to a sum of one rupee per person. Government servants are to have inoculation leave for the necessary period. Railway companies, and other employers of labour, are requested to give similar facilities to their employés.

The resolution issued by the Government on the subject ends by saying that the Lieutenant-Governor "*earnestly appeals to everyone interested in preventing the manhood of the country from being sapped and its vitality destroyed by the scourge of plague, and particularly to the leaders of native society and non-official Europeans who employ labour on a considerable scale, to aid in the endeavour to induce the people to protect themselves by inoculation.*" Subsequent to this resolution the Government of the United Provinces issued orders offering also facilities for those who wish to vacate their houses, and giving detailed and well-thought out directions for the destruction of rats.

Mr. President and Gentlemen, I have endeavoured to place before you the present position of the various measures suggested and tried so far in combating the plague as an epidemic. I have not entered upon the subject of curative treatment of plague, because this would perhaps be outside the scope of this section, and because the result of that treatment leaves much, if not everything, to be desired.

Protection of India from Invasion by Bubonic Plague.

By J. Ashburton Thompson, M.D.

Selection of this topic for discussion by a stranger to India requires justification. I point out, therefore, first, that Australian conditions happened to be so favourable to the epidemiological investigation of plague that data of two classes were there acquired with comparative ease, viz., (*a*) fundamental data which concerned the disease itself and which, consequently, hold good in all countries and under all circumstances; and (*b*) data which concern practical administration, which are liable to modification in different countries by local habits. And then, secondly, I would say that I have no intention of trespassing on the province of the administrator, at least in the details of his work. I propose to speak rather of the statesman, and to point out that which I conceive to be the sole and irrefragible principle which he must impress on administrative staffs, if he would achieve any permanent reduction in the susceptibility to invasion by plague which is so marked a feature of the conditions of life in India.

The fundamental data acquired at Sydney were the following:—

(1) The epidemic spread of plague occurs independently of communication of the infection from the sick; consequently, the infection of plague spreads by means which are external to man, and which are independent of his agency as subject of the disease. The data on which this conclusion is founded were first published in November, 1900.

(2) The plague-rat is harmless to man; it is, nevertheless, the essential cause of epidemics; consequently, some intermediate agent is necessary to convey the infection in efficient form from rat to man. The evidence for this conclusion was first published in July, 1903.

(3) The intermediate agent between rat and man (and between rat and rat) can be no other than the flea foreshadowed by Simond, and, further, actually is the flea. This conclusion also was published in July, 1903, together with the exact observations made in the field from which it was deduced.

The administrative data then acquired were many. They were all referable to the fundamental data; and when it appeared, as it sometimes did, that the conclusions of this class were not in accordance with experience in other parts of the world, it was still found that the differences were apparent and not real, and were easily explicable by the fundamental data already mentioned. For the sake of example, the following instances may be cited. One of them was that transfer of the sick to hospital is a very important curative measure, but is quite without importance as a preventive measure. Another was that there is no such thing as infection of localities or places, although the disease is acquired by resort to certain localities; the explanation is that the local rats are infected, not the places themselves. A third was that clothing never becomes infected with plague, and is never a cause of spread; and it was easily seen that the contrary experience commonly recorded in India was not inconsistent with that conclusion, but was explained by the fundamental datum that the infection is communicated by fleas, which in India very much more commonly infest the people and their houses than in Australia, where such infestation is, for the most part, absent. Observations of the class now referred to may or may not hold good in all respects in changed social conditions; but there was another among them which has not yet been mentioned, and which is certainly of universal applicability. This was that the infection of man was most usually contingent on his being within buildings together with plague-rats; and on considering the fundamental data it became evident that a certain proximity between man and the minute agent of his infection—the flea—must be necessary. Hence it appeared plainly that the exclusion of rats from occupied buildings must be an important item among steps for the prevention of plague, for from the rat alone does the flea derive its power. But more than that, the longer this point was contemplated the clearer it became that the rendering of occupied buildings rat-proof was absolutely the most important item in plague prevention, and even the only one to which the epithet "preventive" could be justly applied. The reasons will be referred to presently; here I would merely note that I advocated this view also first in 1900, and then predicted that its simplicity, and perhaps also its apparent indirectness, would militate against its acceptance by the laity who control the purse, and consequently the means of carrying it out. And it is still the case that attention is concentrated on other measures which, in reality, are merely remedial, or merely palliative, and which are consequently interminable. This, then, is the point to which I wish to draw especial attention; but I must add that I take it to include and to cover destruction of the harbourage which rats find outside, and in the immediate neighbourhood of, buildings. The difficulty of saving the people in a place from attack is proportioned to any difficulty there may be in preventing the access of rats to the buildings occupied by them; but the difficulty of clearing plague away from the place itself is proportioned to any difficulty there may be in removing the harbourage which rats find in the mouths of sewers, in heaps of lumber and rubbish, in loose earth and rubble-fillings, and in dilapidated sheds or the like structures.

It should be noted that the administrator who is faced with an outbreak of plague is perfectly right in relying on immunisation of the people—a possibility laid open to him by the genius of Mr. Haffkine, here present—on evacuation, and on the destruction of rats. These are his only, and fortunately his very effective, means of staying it. But the statesman should be caused to understand that the control of existing epidemics is not a subject to engage his supreme abilities, and that his preoccupation should be how best to diminish the susceptibility to invasion of his country as a whole. The methods just mentioned (I must repeat it) are in fact remedial, not preventive, and consequently they are, as I have already remarked, interminable. If a population be immunised this year it must, if it be reinvaded, be again immunised in a twelvemonth, or a little later; evacuation may have to be repeated even during the same season; and to the killing of rats there is literally no end at all. But every building which is rendered inaccessible to rats may be regarded as a fortress impregnable to that enemy for ever. This, then, indicates the only road the statesman can fitly take; a road, namely, on which every step must be directly towards the goal, and on which there cannot be any backsliding.

The arrest of present outbreaks is a quite different matter from diminution of the liability of the country to suffer them. Removal of the conditions which constitute its susceptibility can alone be justly spoken of as preventive action. And it is, I think, of little use to place scientific truths before the laity unless the expert points out their practical bearing and application at the same time. In order to judge in how far true that is, it is only necessary to ponder the *Gazette Extraordinary* which was published by the Government of India during August of this year. That *Gazette* draws attention to the essential part played by the rat, to the essential agency of the flea, and to the insignificance of deposited infection; but it also expresses the opinion that this knowledge, acquired by it from the remarkably brilliant reports of the Plague Research Committee, will probably not render the task of prevention much easier than it was before. The *Gazette* even mentions the desirability of excluding rats from dwellings, but only to dismiss this method with the remark that it is impossible to expect much improvement in the construction of buildings in the near future. The all important distinction mentioned above between remedial and preventive measures is not perceived.

This pronouncement, then, appears to be rather less far-seeing than might reasonably have been expected. For there are many other considerations which must be entertained besides the crude facts which are recited in the *Gazette.* It should be noticed that plague seems to have taken its place among the endemic diseases; and if the uncertain teachings of history seem to offer some prospect of its ultimate extinction by natural process, it should be borne in mind that present circumstances are vastly different from those which formerly obtained, and especially in relation to traffic. To-day plague is a disease to be fought persistently in India, as, I suppose, typhoid fever and cholera are there fought. No speedy exemption is, in my opinion, to be expected.

It must be frankly said that the method of exclusion is practically impossible in the smaller villages, in the larger villages, and in the lesser towns; but this admission is very far indeed from covering the whole case. In the first place, it is precisely in those smaller and more or less circumscribed collections of huts and houses that the palliative or remedial measures are easily successful and, provided the infection be not reintroduced, permanently successful. In the second place, whence do Indian villages derive their infection? Is it not from the great cities on the seaboard and from the larger inland cities which have become secondary distributing centres? And is it, indeed, quite impossible to apply the method of exclusion in them?

I do not doubt that when a broad and comprehensive survey of all the data has been taken, it will be perceived that the exclusion of rats from occupied buildings in cities is the only measure which can permanently diminish the susceptibility of India to plague; and that, as soon as this principle of action has been grasped, resolutions taken by Government will be conceived in the spirit which animated that courtier who, when he was desired to undertake a business which the king himself thought it hardly possible to carry through, replied, "Sire, if it be difficult, it is already done; if it be impossible—it will be done."

Note.—With reference to this paper the following letter has been received:—

Southern Punjab Railway Company, Limited,
70, Cornhill, London, E.C., 7th December, 1907.

Sir,

In reference to the meeting of the Epidemiological Section of your Society on the 3rd instant, my Chairman, Sir Bradford Leslie, desires me to draw attention to a remark made by Dr. Ashburton Thompson that "Every building which was rendered inaccessible to rats might be regarded as a fortress impregnable to that enemy (plague) for ever"; and in confirmation of that view I am to forward the enclosed report of his speech at our last half-yearly meeting, at which he stated the fact that the members of the native staff on the North-Western State Railway, who reside in rat-proof cubicles, with brick walls, brick and cement roofs, and cement floors are virtually immune from plague. Sir Bradford hopes that this corroboration of Dr. Ashburton Thompson's views may be useful to him. I also to mention that in Bengal, where the climate is humid, water is abundant and daily bathing is the rule, plague does not gain the same foothold as it does in the drier climate of the North-West and the Punjab.

I am, Sir, Your obedient Servant,
URBAN BROUGHTON (Secretary).

Extract from Sir Bradford Leslie's Speech.

"During the half-year under review, *i.e.*, 1st January to 30th June, 1907, the plague has been worse than ever, the total number of deaths in the Punjab being not less than half a million, or at the rate of nearly 25 per 1,000 of the population. This number is greater by 400,000 than for the half-year to 30th June, 1906, and about 150,000 more than for the whole of the year 1905. Even in the town of Bhatinda, with a population of only 13,000, there were over 700 deaths, and in Delhi over 11,000 deaths out of a population of 209,000, or about 1 in 20 of the population of each place. Unfortunately, it is generally young people in the first vigour of their youth who are struck down. It is remarkable that the North-Western State Railway employés, who number some 55,000 in the Punjab, where they are housed in staff quarters on railway land, with proper regard to sanitation on European principles, had a death-rate of only 1 per 1,000 per annum, including their families; but in places like Lahore, where, for want of space, the railway employés have to live in the native towns, they do not escape the prevailing disease. It is hoped that His Majesty's gracious letter to India on this subject will stimulate investigation and remedial measures."

DISCUSSION.

The President (Dr. Newsholme), in introducing the authors, reminded the Fellows that the meeting was a special one, called in the first place to do honour to two distinguished confrères; and, secondly, to enable Fellows to learn that which they were so competent to teach. He did not think it possible to imagine a greater contrast in the conditions under which plague might prevail than those in India and those in New South Wales. In one instance was a community fully invaded by the disease, in which difference of race, religion, and civilisation held good, and in which measures which might be successful under the conditions of western civilisation would obviously not be completely available. On the other hand, there was a city like Sydney, well-governed, inhabited by a people who were our own blood-relations, and who recognised the importance of sanitation. Those were the two classes of experience which would be placed before the meeting. In one case it was a relatively easy task to keep the plague under control; in the other it was extremely difficult, especially when, as was the case in India, the disease was already rampant when Mr. Haffkine's genius discovered the remedy which had done so much to minimise the prevalence of the disease and to diminish its fatality amongst those who were attacked by it. On that point there was no difference of opinion among those who had had the opportunity of investigating Mr. Haffkine's remedy for plague. One could realise the immense importance, in a country like India, of having such a remedy which could be adopted when ordinary measures of sanitary control and prevention of importation were, to a very large extent, inapplicable. Those present would congratulate Mr. Haffkine on the fact that he would shortly be returning to India to resume his most important work there. That work had been interrupted for a short time through no fault of his, and they congratulated not only Mr. Haffkine, but still more, India, in that it was again to have the benefit of his invaluable services. He had said that, in Sydney, the task of keeping plague out and preventing its spread was a simpler one than in India; but that by no means detracted from the merit of Dr. Ashburton Thompson's pioneer work on plague in Sydney. Those who had read his masterly reports on plague in Sydney must have felt with what care he investigated every detail concerned, and got to the bottom of every outbreak. They were masterly expositions of epidemiological research.

The following observations were contributed by Major Arnim, I.M.S.: It is true that in the earlier stages of an outbreak—when only a few foci of the disease are known to exist—the use of the full epidemiological armament of notification, isolation, disinfection, segregation, &c., is justifiable; and it is expedient to isolate the patient, disinfect his house and belongings, segregate contacts, &c. With regard to the isolation of the plague patient, it is a question whether his removal to a suitably situated isolation hospital, where he is inaccessible to the *uninfected* rat-flea, is not quite as justifiable as is the measure—now adopted in the prophylaxis of malaria—of isolating a malarial patient from the possible attacks of the *uninfected* mosquito. In the earlier stages of a plague outbreak the above measures are, I think, justifiable. But in instances where the disease has assumed a widespread epidemic or pandemic form, these measures are useless, and their application to a locality causes unnecessary inconvenience and suffering. We are, under these circumstances, thrown back upon the three lines of defence which experience and observation have shown to be of most value. I refer to (*a*) preventive inoculation; (*b*) the removal of the community from the rat-infected area; (*c*) the removal of the rat from the infected or threatened area. It is upon this latter measure that I would ask permission to say a few words, and upon an aspect of this subject to which I believe sufficient importance is not yet attached by plague administrators. The value of inoculation has already been referred to, as have also the advantages of evacuation and the great difficulties often attending it; the task of efficient rat destruction by poisoning, trapping, &c., has been declared to be "practically impossible"; but no great stress has been laid upon systematising what might be termed "rat prevention." I refer to the taking of simple but rigorous and systematic measures to prevent the congregation of rats in large numbers in areas threatened with plague. Rats are natural scavengers, and will congregate where there is waste food, garbage, or rubbish lying about. Where debris of this nature does not exist, the rat will not be found—he vanishes. As an instance: I have in mind a large Indian town of over 100,000 population where plague appeared in 1897. Among my other duties connected with the outbreak I was asked to take special charge—with regard to preventive measures—of the Sudder Bazaar, an area which was situated between the military and European lines and the native city in which the disease had appeared. The first step taken in dealing with this area was to make a minute inspection of the houses. In the basement of each house was found a mass of garbage—filth and rubbish of all kinds. Only to the person who is well acquainted with the interior economy of the native house of India is known the heterogeneous mass of rubbish which is allowed to collect in the basements of the premises. In this instance I ascertained that the reason of these unusually large collections of rubbish was mainly due to defective scavenging, and to punishment being feared if the debris was thrown on to the streets. Hence, all house-sweepings, organic debris, old rags, and, in many instances, absolute filth had been allowed for long periods to accumulate in the house basements. I enlisted the assistance of the householders, and had all the basements of the houses cleaned. The rubbish was removed by sweepers into the roadways in front of the houses and there burnt (for days afterwards the Sudder Bazaar was enveloped in smoke); and the basements were then lime-washed, and latrine receptacles renewed and tar-painted. Plague never appeared in this area in true epidemic form, and the place came to be considered as protected from the disease, which was virulent in its vicinity, and some people attempted to smuggle their sick into the area, believing that they would become cured there. I believe that the removal of the rubbish from the houses, and the systematic cleaning up of this area, had discouraged the rats from infesting it to an abnormal degree, with a result that the incidence of disease in the area was much diminished. It is a matter of common observance that on occupying a house which has for some time been tenantless, the place may be absolutely free from rats and mice. After a time, when food has been left lying about in the larder, or on shelves and tables, rats and mice will appear. So it is with houses in India, and more especially so on account of the prevalence of the unpaved and uncemented basements which exist in nearly all the native houses. I merely speak these few words in the hope that general cleanliness of houses, and more especially of their basements, will occupy a more prominent place in future plague policy. People should be encouraged to keep the basements of their houses scrupulously clean, and should be advised not to allow any refuse, waste food, old rags, or filth, or debris of any kind to collect in their areas; and should be further urged to keep their cooked food and uncooked food supplies in such a manner as to prevent rats having access to them. The greatest boon to India would be if the natives—both Mohammedans and Hindoos—could be induced to regard the rat as the Mohammedan regards the pig, and that any food or matter with which the rat had come into contact became regarded as spoiled and tainted.

Professor W. J. Simpson said he had had the advantage of reading Dr. Ashburton Thompson's paper, as well as Professor Haffkine's, so that he was in a better position than otherwise he would have been to take part in the discussion. He had read both papers with an interest which was increased by the fact that the authors presented the subject from different points of view. On one point he thought most would agree with both authors, namely, that the rat plague played a predominant rôle in the causation of human plague. Perhaps Dr. Thompson had given expression to that opinion too broadly, for it had to be qualified by the fact that pneumonia-plague, at least, might have nothing to do with rat-plague. Unanimity on the relationship of rat-plague to human plague marked a distinct stage in the etiological and preventive aspects of the disease, because in the one case it allowed of further investigations being undertaken without any disturbing uncertainty on a very fundamental question, and because in the other case it indicated the direction in which plague measures should be taken, and which Professor Haffkine had called a rational method for dealing with plague, which could be done without waiting for the complete solution of the problem which it was hoped might be reached by continuous and systematic investigation. Dr. Thompson had stated his views shortly and clearly, and no one could complain of any hesitancies. On reading the paper one would come to the conclusion that the whole problem of plague was settled, because Dr. Thompson held that the plague-rat was harmless to man, and that the intermediate agent between the rat and man and between rat and rat could be no other than the flea, and actually was the flea. Those views were based on his own observations and on the results of experiments by the Plague Commission. They, however, erred in an inclination to generalise too much on insufficient data. In illustration of that he quoted an interesting case in the last report issued by Dr. Thompson, that of a man and wife simultaneously attacked with plague. Each of them had flea-bites on the drainage area of the bubo. There were no rats at the residence, but at the man's workshop another workman had killed two sick rats and picked up two dead rats, and there were found, in the process of cleaning, the carcases of ten rats in an advanced state of decomposition. Plague bacilli were not found in them, nor in a number of rats trapped in adjoining and neighbouring premises. The husband's illness was attributed to flea-bites received at the workshop, and as the causation of the wife's simultaneous attack could not be put down to fleas in the house, it was stated "it would seem that the only possible source of infection must have been a flea imported to her house by her husband from the factory, which she herself had not visited." The evidence was not very strong in favour of that assumption, but it was about the strongest which had appeared in any of the former reports. Hitherto, with most people, it had been merely a working hypothesis, supported by a few experiments, that the flea was an active agent in the propagation of plague. That hypothesis had been converted into a certainty by the experiments of the Indian Plague Commission, which had established the fact that the flea was perhaps the most important agent in the dissemination of epizoötic plague. The interpretation which he put upon those experiments was that the flea was an active agent in the causation of epizoötic of plague in the rat, but it did not appear to justify the claim that the flea was the only agent, or the setting aside of the successful feeding experiments of Kitasata, Yersin, and Wilne in Hongkong, the German and Austrian Commissions in Bombay, and those of Klein in this country. There was always a tendency to run the newest view to the extreme. It took time to obtain the due perspective, and he thought that was the case in this instance. At one time it was inoculation, then it was feeding, now it was the flea. Might it not be that they were all responsible? When one found that rats were susceptible to plague by inoculation, by feeding, and by the laying of plague materials in the nostrils of rats, it was difficult to see why the flea should be selected as the only agent. That was still more the case with regard to plague being always conveyed by the flea from the rat to man. The experiments on that point had been but few. They were his own in Hongkong and the few made by the Indian Plague Commission, but the most that could be said with reference to them was that the rat-flea could infect the monkey, and probably man, and they confirmed what was pointed out by Simond and Hankin in regard to that point. But that was a very different matter from the flea being the only agent. Monkeys were very susceptible to feeding with plague-infected food; why should man be not similarly infected? In Hongkong, where many *post-mortems* were made, the pathological evidence was not small that many cases of plague, apart from tonsillar and cervical cases, were produced by feeding. If the *post-mortem* records of the cases in the early days of the Bombay plague were examined, there would also be found evidence of lesions of the stomach, intestines, and mesenteric glands in considerable number. Possibly it was because Dr. Thompson's experience had been mostly with bubonic cases that he held such strong views on the flea theory. Septicæmic cases were not common in Sydney, and it was a strange but interesting fact that bubonic cases of plague appeared for the first time only during the sixth outbreak of plague last year. It might be asked what happened to the flea that produced that phenomenon. He thought that under the circumstances all the fundamental facts were not to be found at present in Australia, and that the last word, however desirable it was, had not been said on the causation of plague.

Mr. Haffkine's paper dealt less with causes than with methods of prevention. That gentleman accepted all the theories, for they were a matter of indifference to him, and it was only essential for him to compare the failure of other methods with the successes which attended the use of the prophylactic, and to show the superiority of that method over others. If he, Professor Simpson, had to deal with the epidemic in India, and had the choice of adopting only Dr. Thompson's method or that of Professor Haffkine, he would have no hesitation in selecting Professor Haffkine's. Dr. Thompson's remedy, which was also Dr. Creighton's, was a good one, and must appeal to sanitarians, for he supposed that in rebuilding the houses there would be included the provision of good light and ventilation, as well as protection from rats. But it failed in the very important particular that it would probably be useful for the protection of India when the next epidemic invaded that country, say in about a couple of hundred years. The statesman, therefore, who adopted Dr. Thompson's policy might be hailed by the remote descendants of the present generation as a benefactor, but he would scarcely be considered to be carrying out what were ordinarily understood as the functions of a statesman, namely, the solving as far as possible of the problems which arose for the benefit of the present generation and those of the near future. He would further state that even if the rebuilding of India could be carried out in ten years, much of its value would be discounted by the customs of the people. Wherever the Indian lived he liked to have his grain with him, which was natural, just as our own housewives like to have their stores in the house. Plague had been known to attack Indians and leave Europeans free, even in cantonment houses which were well built, and where Indians had at times been permitted to reside. The reasons for the invasion of plague into such well-built and sanitary houses had been that the rats of the locality had been attracted into the particular houses by the granaries established there. Plague has also occurred in gaols, which were generally well built, and it had occurred even in some of the newly-built houses erected by the Bombay Improvement Trust. Last year he visited several of those houses with Dr. Turner, the Health Officer. The rats gained access to the houses by creeping up the rain-water pipes and by other means. There could be no doubt that the most immediate and probably the most easily applied preventive, if the confidence of the people were obtained, was inoculation. It could be applied on a small or on a large scale. In Calcutta, whenever a case of small-pox occurred in a house, the inmates of the house and those of the immediate surroundings were, as far as possible, vaccinated. A similar arrangement might be introduced in regard to plague. Simultaneously an organisation should be formed to popularise and carry on inoculations on a large scale in every infected centre. Probably that would be done when Mr. Haffkine returned to India. The weak point in the inoculations, however, was that the protective power did not last very long, and so long as that defect lasted he feared it would always be difficult to induce people to be inoculated every two or three years, except under the stress of a great mortality. It was for that reason that, although inoculation must be recognised as a powerful weapon in the hands of the sanitarian, it could not be depended on alone; a general fighting an enemy did not depend only on his infantry. It was impossible to close one's eyes to the fact that the primary cause was still existent, and as we thought we knew what the primary cause was—which was not the case when we depended on vaccination against small-pox—it appeared necessary to go further and attack the cause or causes as known to us at present. If the infected rat were got rid of, it did not much matter whether man got the disease from the fleas of rats, from infected foods, or from other agents. In the chain of causation the rat was the more important factor to deal with, and he believed that just as Professor Haffkine had been a benefactor to India by the discovery of the plague prophylactic, he would add still more to that country's indebtedness to him if he could discover a more potent microbe than Danysz's bacillus which would destroy the rat and yet be harmless to human beings and other animals. It should not be supposed that plague was endemic or epidemic in every village and town in India, and he believed that the policy of a free and unrestricted trade in plague distribution from infected centres to healthy localities had contributed to the present deplorable conditions. Measures should therefore be taken to prevent this, either on the passport system adopted in the Madras Presidency or by others which would readily appeal to the trained sanitarian. With regard to disinfection and its supposed inutility on the grounds stated by the Commission, that a contaminated flea lost its infection in a few days, and that plague bacilli could not be found in the soil, he wished to add his dissent to that which had already been expressed by Dr. Turner. In those particular experiments it might be so, but he thought it was generally agreed that tetanus bacilli lived in the soil, but how often were they looked for and could not be found? To search in an infected room for the bacillus of plague was like looking for the proverbial needle in the haystack. Against those experiments of the Commission were other experiments. How was one to account for the fact that, according to Gladdin, the bacillus would live for over three months on food such as raw and coagulated albumen, turnips, potatoes, plums, apples, cucumbers, &c., or those of Batazoff, in which the organs of plague animals dried in vacuum for thirty-eight days at the temperature of the room, infected animals after that period, and of those of Gotschlich, who found the bacillus alive and virulent in eight and a half months' old cultures which were dried and mouldy. Again, clothes would have to be disinfected, even if it was the flea which only carried the infection, as he did not suppose that the clothes would be opened up and fleas searched for. Even then they would have to be killed, and he took it that destruction by disinfectant was easier than catching them and destroying them, as the Chinese women did, by cracking them between the teeth. For carrying out any of the measures a properly qualified sanitary service was needed in India. It was because of the absence of that service that most of the failures arose. It was also the secret of the failure of the great inoculation campaign in the Punjab, where villagers, instead of properly qualified men and women, were employed to open the battle and assist in the technique of the inoculations. The Japanese had recently four towns infected, and the organisation they brought to bear on the prevention of plague was 1,200 medical men. They had 513 deaths altogether. In the Punjab there were during the epidemic of this year over 600,000 deaths, and there were in 1906 only ten Europeans and thirty-eight native medical men employed to combat the disease. If the whole 750 medical men in the Indian Medical Service had been released of their duties all over India, which was an impossibility, and had been drafted into that one province, it would not have equalled the organisation of the Japanese.

Dr. J. F. Payne said all the Fellows would be very grateful to Mr. Haffkine and Dr. Thompson for their exceedingly valuable papers, more especially as the authors had not remained immersed in the atmosphere of scientific doubt, but had each put their views in the clearest and most definite manner. He did not believe the views of those two gentlemen were opposed, and he did not see why the plans respectively advocated should not be carried on simultaneously. With such a combination of forces it might be hoped that a much more serious impression might be made on the great invasion of plague than by adopting any one separately. With regard to rats, it was clear that in all the places which had been investigated of late during the great pandemic of plague, rats had been found largely concerned with the distribution of the disease from one place to another and with its local production. But it had not yet been proved that that was the only source of plague, and for several reasons. Every epidemic of plague recently described in the great pandemic had been carried from one part of the earth's surface—namely, from the mountain country of Yunnan, in the south of China. There it had been endemic no one knew how long. In that country particularly epidemics of plague were connected with the deaths of animals living underground. That plague was carried from Yunnan to the coast, and thence to the south of China and on to Hongkong, and from there distributed over the world. But plague had come from there just as cinchona plants, wherever found, came originally from America. The relation of plague to the death of rats had been before the profession for more than fifty years. Not to mention some rather obscure earlier reports, in 1853, Surgeon-General Francis, of the Indian Medical Service, published a report in which he described how the mountaineers of Kuma, on the slopes of the Himalayas, had turned out of their houses on account of plague when they observed dead rats. That had been known to people who had investigated plague in other parts of the world. For a long time the chief places for the investigation of plague were Mesopotamia, Baghdah, Kurdistan, and Persia, but not in the Far East. Those investigators in Persia and Baghdad were very careful and conscientious people, and included Surgeon-Major Colville and a French physician, Dr. Tholozan. Surgeon-Major Colville said they had never seen anything of the kind observed in the Himalayas. Though his own personal experience was very small, he wished to relate one incident. When he went out, in 1879, to investigate the plague on the Lower Volga, in the province of Astrakhan, especially at the village of Vetlianka, which had become historic, the epidemic was practically over, and they only saw a few patients who had recovered. It was being much talked about, but never a word was said about rats. His own impression was that the common European rat did not exist in that country at all. The great naturalist, Pallas, who travelled there in the last century, said it did not exist there then. While waiting in the village with nothing to do, it was their custom to walk about and into the neighbouring country, where they saw many burrows made by a little mouse. He noticed many skeletons of these animals, and on asking about them was told that a number of the mice had died during the winter. He believed it was the *Mus montanus*. Since then it had occurred to him that this might have had some connection with the epidemic. The plague had in many other places not been connected with rats. At present the Yunnan plague was being carried into Egypt and other old seats of plague, and it remained to be seen what would happen. Therefore he did not think there was evidence that the connection of plague with rats was a universal law. He had no doubt that the evidence in regard to fleas was correct, but it was not necessary to suppose that clothing never transmitted the plague. People who were just dead might have clothing which might have contained fleas. In the celebrated village of Derbyshire, which had plague communicated from London, it arose from the clothes being put before the fire to dry, and it was well known that the flea could jump. He thought that they were not entitled to say that the cure or prevention of an epidemic disease like that by inoculation had no effect in checking its endemic prevalence. With regard to malaria, for instance, though it was strictly local, if there were a population saturated with quinine mosquitoes could not get hold of the plasmodium and carry it about, and this had an effect in stopping malaria. Quinine not only cured the individual patient, but diminished the prevalence of the disease. Therefore in India, if at one time there were hundreds of thousands having plague, and if that number were greatly reduced by inoculation, the chances were that the dissemination of the bacillus, the parasitic circle by which the parasite was carried from one animal to another, from man to the lower animals, and from the lower animals back to man, would be checked; it was scarcely fair, then, to say that inoculation had only a temporary effect.

Colonel Macpherson said a good deal had been said about the effect of inoculation in preventing plague, also the effect of getting rid of rats from dwellings. It had also been said that the flea was the conveyor of plague from rats to man. But he wished to ask Mr. Haffkine and Dr. Thompson whether they had made many experiments as to the manner of preventing the flea from biting man. One knew that there were many insecticides used by people in common life for the purpose of preventing themselves being bitten by fleas; and if the flea was the transmitter of plague it would surely be a simple process for each individual in the community to protect himself by using a definite insecticide.

Dr. Sandwith said that nobody who had read Dr. Thompson's reports could do anything but echo the President's praise of them. Those reports first converted him to the rat theory, and later to the rat-flea theory. He was certain the rat theory was correct, and he believed the other was right also; but he agreed with Professor Simpson that it was not fleas alone which caused plague. In his paper Mr. Haffkine said: "Though general statements to this effect have been made by earnest observers, I am not aware of a precise and convincing demonstration by experiment of a case in which disinfection arrested the development of an epidemic of plague." He (Dr. Sandwith) was very much in favour of disinfection in preventing the spread of plague, because in Egypt since 1899, though the officials of the Public Health Department had not stamped out plague they had kept it under, and this had been achieved without any of the special means recommended in the papers read to-night. Disinfection had been carried out in two ways; first, by filling up the rat-holes and destroying the rats, by removing rubbish, whitewashing and cleaning buildings, isolating patients, and watching "contacts." That was found to be insufficient. A second measure which seemed to be of some importance was washing the floors and walls of rooms with corrosive sublimate, 1 in 1,000. That was found to be expensive, and the natives complained when they came back to their homes that their chickens had died; so for several reasons it was temporarily given up. But in the villages and houses where corrosive sublimate was used in addition to the ordinary disinfection process, plague had never yet returned, though it had often returned in places where this extra measure had not been adopted. A reference had also been made to the domestic cat, and he wished to refer to that because Major Buchanan, in India, had proposed that the plague could be minimised by increasing the number of domestic cats. But the cat is susceptible to plague, not quite so much as the rat, but still to a dangerous extent. He asked Mr. Haffkine why he said that the native of India was more susceptible to the disease than the African and European. He (Dr. Sandwith) did not know any reason for considering the African and the Indian to be on very different levels of susceptibility. It had been said that Dr. Ashburton Thompson omitted reference to pneumonic-plague, but plague had so recently reached New South Wales that the authorities were fortunate in having stamped it out before pneumonic cases had occurred. Pneumonic-plague was a term adopted in 1896 from Bombay, although previous epidemics had been known as "cough-illness." Pneumonic-plague in Egypt had sometimes caused eleven deaths in a house of eleven people. He did not suppose that the flea was responsible for that pneumonic-plague, except indirectly. Any case of pneumonic-plague may become septicæmic, and secondary pneumonia sets in, and then the patient disseminating his sputum can cause primary pneumonic-plague. He hoped Dr. Thompson meant that not only the laity—who should be instructed by medical men, and only by them—but also the medical men should work, not only between seasons of prevalence as the various outbreaks were called, but all the time, as some plague was present every month in endemic countries, and the fight should be continued until the disease had been absent among humans for at least a year.

Dr. Fremantle said there were many suggestions of definite theoretical values which, on being put to the test, were often found wanting in regard to plague, and he would be glad to hear whether one or two in particular had been tried. In regard to houses, he would like to hear whether weight had been given to the method of building which he saw at Rangoon, where, building being carried on on land largely reclaimed from the Irrawaddy, houses were built on piles, and in such a way, thanks to the general foresight of the sanitary department, that there was a clear foot of daylight between the ground and the floor of the house. It seemed also desirable to separate adjacent roofs in the same way as in this country parapets were provided to prevent the spread of fire. In such a form there would be a really rat-proof house. Whether that was the reason that Rangoon had never taken plague he did not know, but there was the fact, and he did not think it was simply due to a thoroughly carried out quarantine system. There might be some similar reason in the construction of their houses for the immunity of Japan from plague, notwithstanding that there was a good deal of intercourse between China and Japan. At any rate one saw the reverse system of house-building in Hongkong coincident with an annual recurrence of plague. There the rats not only infected the houses, but actually burrowed again into the brittle bricks which were used within a few days of the most thorough disinfection. Unless the approach of rats was cut off, it would be of little use to rebuild the houses. It would surely be well to start experimental schemes in the centre of plague-infected areas, in villages, for instance, in the Bombay Presidency and in the Punjab; that could be done without difficulty, and different schemes could be tried in different batches of houses. It had been said that the rat should be exterminated, and those who, like Dr. Thompson, had tried it in earnest said it could not be done. He (Dr. Fremantle) thought they were, in that matter, going beyond their province as medical men, and were not giving due weight to those essentially qualified to investigate it. They were dealing with a problem outside their profession, and required for its solution the assistance of a naturalist like the late Frank Buckland or the present secretary of the Zoological Society, Dr. Chalmers Mitchell, who would understand the different methods of exterminating one pest by another set of animals. In India very much was to be done by means of education, and he hoped the Government would take up the question of education in the schools, so that the community might be instructed in the general methods employed in combating the plague. A great question was how to induce the people to accept inoculation. In the Punjab the plague officers were welcomed by the headmen of the villages and those who wish to stand well with the Government, and they and their families were inoculated, but unless plague was actually prevalent the number of inoculations would be limited to 120 or less. It might be well to adopt some method of stimulating them through a monetary payment to the headmen of the villages. Finally, he urged that the question was an Imperial one, and therefore there should be definite correlation between the various Boards and Departments interested in the matter throughout the Empire, rather than action on isolated lines.

Dr. C. J. Martin, F.R.S., said he had listened to both papers with great interest, but it was too late to discuss them at all fully. In Dr. Haffkine's paper there was so little matter that was controversial that he felt he must agree with him when, at the end of his paper, he pointed out that at the present time the most hopeful method for India was the palliative. As to the method in which the substance was given, all must have been struck by the extreme modesty with which the facts were presented. Even if it had been presented in a different way there would have been little cause for complaint. He listened to Dr. Thompson's paper with some emotion, because that gentleman was his earliest preceptor into the mysteries of epidemiology. A good many years ago Dr. Thompson asked him to read over a paper on the "Epidemiology of Leprosy," perhaps on the principle at the bottom of trying a substance on a dog before giving it to a human being. He did not understand much about the subject then, but the paper was crowned with a prize as being the best paper on the "Epidemiology of Leprosy" in any country, so probably the experiment was justified. But he could not allow to pass without comment the part where Dr. Thompson said that India should be rebuilt. It would be difficult to rebuild India, with 300,000,000 people, most of whom had not got houses, as we understood the term. He did not know whether the concluding passage of the paper, relating to the courtier of the king, came from the "Arabian Nights, but it might well have done so. He hoped that king had a firm treasurer, because ultimately everything of the kind became a financial matter. Every unit of the population of India had but a small amount of money. In the finances of the country there might be a surplus of a million or so, but if the whole wealth were divided among the people they would still be very poor. It would be impossible to carry out in such a country measures which were successful in a city like Sydney, with its wealthy population. In conclusion, he wished to pay a tribute to the extraordinary epidemiological acumen by which Dr. Ashburton Thompson was led, quite early in the study of plague, to realise first of all the essential dependence of human epidemics upon rat epizoötics; and, secondly, to the fact that there must be some intermediary between the rat and the human being in order that a rat-plague might cause a human epidemic.

Dr. Chalmers (Medical Officer of Health, Glasgow) said he had scarcely any reason for interposing in the discussion, because one of the papers was on the prevention of plague in India and the other was devoted to a method of combating plague which was not applicable to this country, and which he doubted the suitability of to India. He said that because in this country for two or three generations we had had a similar experience in regard to small-pox, we had not yet succeeded in convincing people that they could, by vaccination, protect themselves against small-pox. So he was not hopeful that, without a panic in India—which no one wished to see—it would be possible to press inoculation to the extent necessary to stamp out the disease, because in twelve months it might be necessary to do it all over again. The whole genius of the country was against the rebuilding of houses rat-free; it had taken two generations of medical officers to persuade the authorities that even in the matter of ordinary diseases the rebuilding of houses was necessary. And all knew how slowly rehousing went on, even in slum areas of England and Scotland, and one asked whether it was likely to be more successful in the case of plague. His own knowledge of plague was acquired in this country, and the experience of anyone here was that there was first of all a genial tolerance, as of a momentary vagary on the part of the medical officer; and secondly, there was a discussion as to whether this or that should be done, no credit being given for acting as a reasonable being. All regarded the rat-flea theory as having some association with plague. The work of the flea had been demonstrated beyond cavil in the last report from India. In his first experience of plague in 1900 he talked the matter over with Sir Thomas Fraser, and told him he was worried about the rats, as people told him they were kept awake at night by them. Sir Thomas's reply to that was that unless the rats were seen and came into the open there was nothing to fear, and that that was the experience in India. But that was not the experience in Glasgow. They endeavoured to catch the rats, but none of those caught were found to have plague, except one, which was caught in the ordinary run. Several times rats were caught which had plague, but no one near was suffering from the disease. The most recent experience was in a particular building, where there was a sanitary officer on duty most of the day, police constables occasionally, a caretaker, and a Sunday-school class muster. In that building thirty-one rats died, and by the merest chance the thirty-first was found to have plague. Hankin, two or three years ago, suggested that while one might accept the rat as being a continuer of plague, possibly something made the flea at one time capable of carrying the disease and another time incapable of doing so. That was only part of the larger question as to why we were having plague in the last ten years. If any explanation of that fact were forthcoming, any light as to means of overcoming it might be clearer. He did not know whether the killing of rats would do any permanent good, for there was a natural law that the birth-rate of any species was directly related to its death-rate, and possibly the result of a vigorous campaign against rats might be an increase in their birth-rate. In India it had been said there were now as many rats as ever, notwithstanding the enormous destruction of them during the last ten years. With regard to disinfection there were two views to keep in mind. The plague organism must be assumed to live outside the body, but only to a limited extent. If chemical methods of disinfection were used there still remained the flea. He had used formalin, but air-breathing animals would not be affected by formalin. It was known, from the work done in India, that a flea fed on a septicæmic rat would communicate the disease for a definite series of days if it were fed daily. How long would a flea not fed in the usual way live? If the flea was capable of transferring the infection from one animal to another, and if a rat could live without feeding for that period, how far might it travel? He asked because of a certain association with rags in his own experience. Recently there was some cause for suspecting that rags might have caused a case of plague. And in order to catch the rat-flea guinea-pigs were put in cages in the rag-store. Human fleas were caught in the rag-store, but no human fleas were caught in the house. They put human fleas into test-tubes, and allowed them to have plenty of air, and until the ninth day those fleas remained active without any food at all. He did not know whether the rat-flea would live longer. With regard to Mr. Haffkine's proposal as to the disposal of the dead he (Dr. Chalmers) did not appreciate that. He had been anxious over the dead who died from plague in Glasgow, and wanted to have cremation, but failed. He therefore arranged for the burial under restricted conditions. But even in a body dead twenty-four hours it was very difficult to recover the organism in a virulent condition. It had already undergone considerable degeneration. There were many things in the character of the organism which seemed to determine its virulence.

Mr. Haffkine, in reply, said that owing to the lateness of the hour he would deal only with one or two points, viz., with those on which he had been asked for some information. In reply to Colonel Macpherson he said that Dr. Turner, Health Officer of Bombay, had given attention to a plan of protecting houses from fleas by means of naphtha or petroleum products. Certain of his observations appeared encouraging, and the plan was being tried further in Bombay, Poona, and elsewhere. Attention had also been directed in India to the possibility of avoiding flea-bites by oiling the skin with mustard or other oils used by Indians of certain castes. The matter called for close and persevering investigation. Dr. Sandwith had put to him one or two somewhat difficult questions. The first concerned his view as to the difference in the susceptibility to plague of Indians, Europeans, and Africans. Somalis, Sidi-boys, Kaffirs, and Europeans of all classes when attacked with plague recovered comparatively easily, whereas in Indians the proportion of deaths to cases was often as high as 70 per cent.; in the other communities it rarely went above 35. From the information kindly given him by Dr. Sandwith, and that which appeared in publications, he concluded that the latter figures held good approximately also for the Arabs in Egypt, at any rate in the case of the endemic form of the disease. The fact that among Europeans inoculated against plague fatal attacks were yet unknown, while in Indians they were observed in a certain proportion of cases, and that in the former the immunity conferred by the inoculation was apparently of a longer duration, seemed to him to stand in relation to the same differences between the two races. If Africans, Arabs, and Europeans showed these advantages in ridding themselves of the plague infection when the attack was already on them, he surmised that they had the same advantages when struggling with the virus in the incubation stage and endeavouring to ward off the first onset of the attack. Dr. Sandwith had, further, referred to his statements regarding disinfection, and quoted the villages in Egypt where the treatment of native huts with corrosive sublimate had been seen to permanently free them of plague. He attached great weight to Dr. Sandwith's observations, and must plead ignorance of the facts he referred to. As far as his present experience went, he had not known cases pointing to a relation between disinfection and the cessation of an outbreak of plague. He was open to conviction, and held the opposite opinion entitled to attentive and earnest consideration.

Dr. Ashburton Thompson said, in reply, that it was too late to discuss all the interesting points which had been raised, but he would touch on some of them. Drs. Payne, Simpson, and Chalmers had all declined to admit that the rat was the sole cause of epidemic plague. He would first ask what other cause had reasonably—nay, he would even say had plausibly—been suggested? However, their hesitation rested in reality on negative evidence, namely, the non-discovery of plague-rats in certain places. But he had again and again remarked on the difficulty there most often was in detecting disease of the rats on any area; and, while the older observers had no means of identifying the cause of death in any carcases they may have encountered, in the accounts of more recent epidemics there was no evidence at all that an adequate search for plague-rats had been made. Dr. Chalmers went even further. He was able to say that at Glasgow he had found no plague-rats in close association with cases; where cases were found there were no plague-rats, and where plague rats were found there were no cases. He welcomed that statement, for it represented his own early experiences. But he had had a more extensive and a more prolonged opportunity than had fallen to Dr. Chalmers, who, if he had had the chance, would have found ultimately that his observation, correct though it was, was incomplete; and he would unavoidably have come at last to the conclusion, already formally expressed by the speaker, that the plague rat was harmless to man save in the presence of an intermediary agent. Professor Simpson had fallen into one or two inadvertencies which it seemed important to point out, just as in the course of lectures recently delivered by him he had asserted that plague had occurred at Sydney in a mild form—an assertion which was not founded on any fact. Professor Simpson, in the course of his remarks, had quoted a case in which the speaker had appealed to the agency of the flea to explain the observed facts, as though the facts had been adduced to establish the agency of the flea; and he had said that this case was about the strongest evidence which the speaker had at any time adduced in favour of the active agency of the flea. But, in fact, the epidemiological evidence for the reality and the essential character of the agency of the flea was of a totally different kind, and had been set forth four years ago, in the speaker's second report, not in the sixth report from which Professor Simpson had quoted. However, that was generally known to those specially interested in plague; and after having remarked that his suggested remedy was not the same as Dr. Creighton's, as Professor Simpson had alleged (for Dr. Creighton thought that the infection of plague was taken with the breath from the ground-air, and not from rats, nor from any source other than that), he would conclude by saying that as he was unable to share Professor Simpson's views on the pathology of plague, there could not be any common basis of discussion between them. Dr. C. J. Martin's kindly criticism contained the only direct reply to his suggestion which had been made, and for well-known reasons it was entitled to the highest consideration. Dr. Martin had strongly asserted that the rebuilding of India had been demanded, and was evidently impossible. He would remind Dr. Martin of the maxim "*Divide et impera.*" That which appeared impossible when viewed as a whole, assumed a different aspect when it was regarded in detail; and he thought that if the fact that the infection was present in the concrete form presented by the animal body, in particular places, and was thence by mechanical agencies transported afar, there to form new local centres of infection and distribution, were more carefully considered and dwelt upon, it would be seen on reflection that his recommendation was far from being chimerical.

APPENDIX G.

REPORT to Section V of the XIVth International Congress of Hygiene and Demography on the mode of Spread and the Prevention of Plague in Australia.—Berlin, 1907.

By J. ASHBURTON THOMPSON, M.D., D.P.H.,

Permanent Head, Department of Public Health, Government of New South Wales.

PREFACE.

THE way in which plague spreads is one and the same everywhere. If it has seemed to be not identical in all countries, I think observed differences casual and dependent on local habits. Man plays no part in it. Plague epizoötic on the rat is the essential factor in diffusion of this disease and in production of its epidemic form. Yet the plague-rat by itself is impotent. Its infection cannot be commonly communicated to man except with help of an intermediary. The efficient intermediary is the flea, which infests the rat and occasionally attacks man after its proper host has died. Prevention of epidemic plague consequently lies in habitually maintaining a distance between the rat and man, for measures directed against the flea can have scope only in special circumstances. The requisite separation between man and rat will be better secured by improving the construction of buildings than by attempts to exterminate the rat.

These conclusions were deduced solely from epidemiological observations made under favourable circumstances at Sydney in 1900 and 1902 ; they have since constituted the principles on which all efforts towards the control of plague in New South Wales have been directed. They were first published in July, 1903, and they have now been confirmed by the experience of five subsequent years. The data then collected reveal—as far as they go—the natural history of plague. Deductions from them form a complement to results obtained under experimental conditions in the laboratory, and may be used to control theoretical applications of the latter to explain field-experience.

REPORT.

1. Australia escaped invasion by plague until after the disease had appeared at the capital of New Caledonia (1), an island which lies a thousand miles from Sydney, in the fourth quarter of 1899. The infection entered by way of Sydney, where attack in the first case occurred on 19th January, 1900. But the people had been threatened from the time plague appeared at Hongkong (2, 3), and their danger was apparently increased when it began to prevail at Bombay (4), and at Mauritius (5) ; for with all these ports Sydney has communication in the way of trade, which in the case of the two former places is regular and frequent. In short, it had seemed extremely probable that Sydney would be infected sooner or later long before its infection actually took place. Hence it had been my business to study the details concerning plague which were published from time to time during the six years 1894-1899, with a view to fixing upon some plan by which initial action might be guided as soon as the disease should appear.

2. Decision on the available material was difficult, although all that was required was some plausible hypothesis of epidemic plague to be held tentatively, and entirely subject to the results of experience. There was no lack of quantity, and on the clinical side it was nearly complete ; but on the epidemiological side it was undigested, inexact, contradictory, and incomplete. Especially the fundamental question as to the share taken by the sick in diffusing the infection remained unanswered ; in the general opinion it was predominant, and even to-day its extent, its nature, and consequently the conditions by which it is limited, remain uncertain for the majority. Two papers had been published, however, which, (and which alone) seemed to me to constitute valuable contributions to the epidemiology of plague. E. H. Hankin (6) had shown reason for thinking that the degree in which plague prevailed stood in relation to the accessibility of dwellings to rats, and in no relation at all to the poverty, filth, and bad ventilation in which people who inhabit dilapidated houses usually live, At the same date P. L. Simond (7), in a brilliant and penetrative work, expounded his reasons for thinking that plague usually resulted from inoculation, that inoculation was commonly effected by a parasite, and that the parasite ordinarily concerned was the flea. As to matters of fact these two papers were suggestive rather than conclusive, and for that reason, perhaps, had not the influence on the course of subsequent investigation to which, as it has turned out, they were entitled. However, on comparing them with the contradictory records already referred to, it appeared to me that they went far towards reconciling the latter. I determined, therefore, to guide initial action by them.

3. The defects in the evidence available to Hankin and to Simond, which had led the former to suggest that fragmentation of the carcases of plague-rats by ants might so disseminate the infection as to contribute importantly to epidemicity of the disease, resulted from the conditions under which they had been compelled to work. Consideration showed it to be unlikely that good evidence on many important points would or could be gathered until an outbreak should occur among a civilised and homogeneous people, under circumstances in which particulars concerning the infection of a majority of the individuals attacked could be learned with approximate accuracy, and in which the events of the epidemic as a whole could be discovered with completeness. The requisite opportunity seems first to have occurred at Sydney, where the population of about half a million was wholly white, wholly civilised, spoke the mother-tongue of the observers, and had been well-trained in obedience to the peremptory discipline of the health authority in the course of several epidemics of small-pox which had been summarily suppressed during the preceding twenty years. The first outbreak (8) lasted from January to August, 1900, and consisted in 303 cases. A plague-free interval of fifteen months ensued, terminated by commencement of a second outbreak (9) in November, 1901, which lasted till June, 1902, and which consisted in 139 cases. It will be noticed that the numbers of cases were on the one hand large enough to avoid observational error, and on the other not so large as to cause embarrassment.

4. The question which most urgently required answer concerned the share taken by the sick in diffusing the infection, and on that point attention was concentrated during 1900. The evidence was as follows :—The requisite particulars were learned in 289 of the 303 cases. The 289 patients occupied 276 dwellings which for the most part were widely separated from each other. Of these dwellings 266 harboured but a single case apiece, although 37 patients had died at home at or before notification, and although a large majority of the remainder had lain at home three days or more before their cases came to knowledge. In 1902 these observations were completely corroborated. Thus, 124 of the 139 patients occupied separate dwellings, and 115 of these dwellings harboured but a single case apiece ; 14 of the patients had died before notification, and as in the previous year most of the remainder had remained at home for three days or more before they were notified. Still, some houses did furnish multiple cases in both years, namely, ten houses in the first, and nine in the second outbreak. These exceptions afford the means of trying the rule of non-communication of infection from the sick which is indicated by the experience in general ; they must, therefore, be examined in detail.

5. The ten households of 1900 yielded thirteen secondary cases. They could be divided into three groups. Group A comprised three households, each of which furnished a single secondary case. In them the hours of attack were so nearly simultaneous that communication of the infection between the primary and the secondary cases was excluded by the shortness of the interval. Group B also comprised three households, each of which yielded a single secondary case. A precisely contrary condition excluded the possibility of communication between the members of these pairs ; it consisted in the length of the interval. Not merely did this exceed twenty-two days in all of them, but in it the primary patient had been separated from the rest of the family, the latter had been removed from home, and the house with its contents had been cleansed ; further, in only one instance had the primary patient left hospital and rejoined the family before the secondary case occurred.

6. In Group C were four households in which the time-relations of the successive cases were such that communication of the infection from the primary patients to the remainder was possible. All of the cases, both primary and secondary, were bubonic. One of these houses yielded four secondary cases. The primary case was removed within twelve hours of attack ; the rest of the household remained at home for two days, and were then removed. On the third day after isolation of the primary case two, and on the fifth day two more of them, fell ill. They were all under medical observation, and the hours of attack were seen to be very close in each of the two pairs ; the first pair was isolated from the second pair at the first sign of illness. In two other households of this group which yielded one secondary case apiece, the intervals

between attack of primaries and secondaries were three and four days; the components of both pairs fell ill at home before notification. In the fourth household the secondary case occurred in a child who had occupied the same bed with her mother during the latter's fatal illness, which had lasted eight days, and who was attacked twenty-four hours before her mother died. Interpretation of the examples in this group is facilitated by comparison with the circumstances of Groups A and B. These show that the time-relation is of secondary importance. Exposure of both or all of the infected members of each household to the same conditions appears to have been the determining factor, and the circumstances of Group C admit this explanation. When further comparison is instituted with the teaching of the 266 households in which no secondary case occurred, then, I think, the question of causation of the secondary cases in Group C is answered. Regarding them as a whole, it seems very improbable that the cause could have been communication with the primary patient; but it is possible, or even likely, that the last case may have been so caused.

7. The apparent exceptions turn out, then, to corroborate and reinforce the more common experience. It is unnecessary, therefore, to examine the nine exceptions met with among the 124 households of 1902 at the same length, since they furnished fifteen secondary cases which presented quite similar characters; but the features exhibited by one group were so striking that they must be detailed. This Group D consisted of seven cases which occurred among a large number of people who lived at an hotel. Of these seven persons, five were attacked at the hotel; but before the first of them had fallen ill the other two had removed to two different dwellings at a long distance from the hotel and from each other, neither of which could be suspected of infectiveness. They had left the hotel in perfectly good health, and had not again communicated with it, nor with its remaining inhabitants, nor with each other; yet they fell ill at their new abodes —the one two days, the other three days after having arrived there. No cases occurred in the two households they joined.

8. At the same time two other observations which bear on the question of communication from the sick were made. Total want of connection between successive cases was most often established with certainty; and the interval between them was often longer, and even much longer, than the incubation period of the disease.

9. All this evidence thus checked appears to me decisive, and to warrant a general rule, namely: The *epidemic* spread of plague occurs independently of communication of the infection from the sick. This general rule furnishes an indispensable foundation for all further investigation, and it carries with it a corollary which can be used as a touchstone of truth in many doubtful conjunctions, namely: The infection of plague spreads by means which are external to man, and independent of his agency as subject of the disease.

10. I do not know what caused the contrary opinion to be held in former times, for the grounds of judgment seem to me—in as far as I am acquainted with them—to be seriously defective. If, however, question concerning the causes of epidemicity be separated from question concerning possible communicability, then the latter must be answered in the affirmative. Primary plague-pneumonia furnishes a conspicuous exception to the general rule, and the reason of the old opinion may well have lain principally with it, though it be now relatively uncommon, easily managed, and far from giving rise invariably to series of cases. The other forms also cannot be denied a possible importance in those days which, under much improved social conditions, they no longer possess; and, indeed, present-day experience among half-civilised and poverty-stricken peoples rather seems to warrant this speculation, at least if imperfectly recorded experiences be liberally interpreted. In short, it appears to me that the dictum (10) "every person who suffers from plague is capable of communicating the disease, and the danger is greater or less according to the form the disease takes" is justified, but in a general sense. It is useful as a warning. It omits to recognise the fact that realisation of the epidemic-danger depends not merely on the form of the disease, but chiefly on surrounding circumstances. If humanity and economy are to be regarded as desirable features in measures for the prevention of plague the general rule must be recognised, and the reasons why exceptions to it sometimes occur, the natural limits to their possible effects if in any case they happen to be overlooked, and the conditions, if any there be, under which alone they could acquire national importance, must be defined.

11. The foregoing analysis of the groups of associated cases shows that the primary patient was not the point around which they centred. It suggests that they were linked by the influence of some external condition to which all their members had been alike exposed. This hint accrued in the course of an inquiry which sought to discover merely whether the sick, as presumed centres of infection, in any way influenced the healthy who were in contact with them; consequently it was concerned merely with dwellings where cases had been harboured without any reference to the manner in which those cases had arisen. The suggested association of the infection with place was examined in a different way. If place were the determining factor, then groups should be discoverable which were composed of persons who were independent of each other in every respect save recourse to the same place. Such groups were found without difficulty. To mention those only which were indisputably established in 1900 by exhaustive investigations into the personal habits and circumstances of each of their component members, analysis of the records for that year resulted in recognition of seventeen such groups. They consisted of from two to four persons in each, and they comprised a total of forty-three persons who occupied forty-three separate dwellings. These dwellings were almost always distant from each other, and for the most part stood in neighbourhoods which at no time fell under suspicion of infectiveness. The sole distinguishable bond between the components of each group consisted in their resort during the day to the same workplace, to which they did not return, or where they did not remain (as the case might be), after the onset of illness. Thus the evidence that the infection was not diffused by the sick met its counterpart in this clear evidence that infection could be taken by resort to places where no sick person had ever lain. Other such groups were noted in 1902 and in subsequent years.

12. Consequently it then fell to be inquired in what the infectiveness of locality consisted. A possible explanation was at hand. From antiquity it had been observed that rats sometimes died in numbers in places where man died of plague; and after 1894, when it was first made possible to identify the disease in the rat with the disease in man (11) this coincidence was more regularly recorded. It was even observed occasionally that the rats suffered first. But whether the rat infected man, or man the rat, and whether both did not acquire the disease independently of each other from some source which was common to both, remained undetermined; and yet, as time went on, the often-observed coincidence came to be generally spoken of in terms of cause and effect as between rat and man, though still no definite warrant had been derived from experience, and though it had not infrequently been reported that epidemics had occurred where no evidence of presence of an epizoötic had been gathered. And while, on the one hand, the meaning of this coincidence could never be deduced from repeated examples of it in whatsoever number they might accumulate, on the other a too exclusive application of bacteriological possibilities to explain the data gathered in the field tended to divert attention from it even as a phenomenon which required explanation, and allowed a preponderating share in the causation of epidemics and epizoötics alike to be ascribed to imagined factors. In the meantime this clue had been taken in hand at Sydney, and an attempt had been made to follow it through the maze which apparently contradictory observations had gradually woven. It broke. The general coincidence on areas was once more recorded, but the precise and more intimate connection between rat and man which would have revealed opportunity, at least, for direct communication of the infection could not be made out.

13. Had this result been purely negative it might well have been tentatively ascribed to merely incidental circumstances which, it might have been supposed, would be eliminated as experience was gained. But positive evidence also accrued which seemed to throw doubt on the efficiency of the rat as the essential cause of epidemicity. Thus in 1902 plague was bacteriologically identified in rats found on forty inhabited or frequented premises, and yet these findings were accompanied by plague in man only four times. Again, when plague in the rat (whether identified or inferred) and plague in man did coincide on the same premises, much the most often but one person suffered out of several or even many who seemed to have been equally exposed, all of whom might safely be regarded as having been equally susceptible. Again, it was observed that the handling of dead plague-rats was but rarely followed by infection; there were indeed apparent instances to the contrary, but it almost always (not quite) turned out that the handling had taken place much too recently or too remotely to have been connected with the cause of attack. Besides, even at that date it had become clear from common laboratory experience that dead plague-rats are practically harmless provided their juices are not inoculated into those who dissect them. Two other observations to similar effect were made. When plague-rats and cases did exist on the same premises it was most often possible to exclude contact, and even close neighbourhood, between them; and rarely the closest scrutiny failed to detect either rats or traces of infestation with them on premises where circumstances compelled the conclusion that the infection had been received. Contact with any live rat was found to be an extremely uncommon occurrence, and no case of rat-bite (which if the rat happened to be infected would almost certainly communicate the disease) was heard of. All of these data have not equal weight; nevertheless, it thus appeared that the familiar crude observation of coincidence on the same area between plague in the rat and plague in man which is logically incompetent to establish causality as between rat and man, was incompetent in fact also as soon as it was examined under circumstances in which knowledge of all the details could be got in a considerable number of instances.

14. The effect of these carefully established data might well have been to divert attention from the rat, but for the knowledge already acquired that the infection spread by means which were external to man. Thus the immediate direction which further inquiry must take was indicated. And it was noticed first of all that the infection might suddenly manifest itself on new areas which were separated by wide tracts of plague-free houses from any other area up to that time infected, and might there set going a sub-epidemic which should run its complete course independently of the course of the disease on other areas. This event, of which I have now recorded many instances, showed that the infection could be harmlessly transported over inhabited districts of wide extent, be planted afar, and there could take effect. In this phenomenon, it will be observed, there would be nothing unusual or noteworthy but for the fundamental observation that the infection is not epidemically diffused by the sick; and as it is not diffused by the sick themselves, so it seems to follow that it is not diffused by fomites either, for otherwise the evidence on the former point drawn from examination of the 266 and of the 124 plague-houses of the first and second outbreaks could not have been decisive, and might, perhaps, even have turned out to be unintelligible. It is also worth noting here that while, at Sydney, a very short line of wharves at which the produce trade (hay, grain, chaff, potatoes, bananas, &c.) is carried on, has always been the immediate source of the local infection, all the sub-epidemics referred to began either at produce stores or at stables to which produce had been carried from the neighbourhood of those wharves.

15. It was further noticed that the connection between the infection and locality was transient. Thus the outbreak of 1902 occurred on the area which had been invaded in 1900; but as the number of cases was less than half as large, parts of it which had suffered in 1900 were entirely spared in 1902. Still, reappearance on parts of the same area, though only on parts of it, permitted a suspicion that the infection might not have been completely removed from it in 1900, and this necessitated a closer examination. But first, what at bottom is meant by the convenient phrase "infected area"? As soon as this question is formulated it is seen from the data furnished by the grouped cases analysed above, that the infectiveness of areas depends solely on infectiveness of particular buildings standing within them. Perhaps the most striking feature of the epidemic diffusion (at least, after its independence of communication with the sick) was the erratic and even capricious way in which the disease manifested itself. It appeared in buildings which, though they stood in the same neighbourhood, were yet well separated from each other. There was absence of consecutive attack of adjoining buildings. It became clear, also, that the infection of man depended, not on his inhabiting a neighbourhood, but on his having visited particular buildings within it. Now, when incidence of the disease on buildings in the two outbreaks was compared in detail, the following data resulted :—In the first, circumstances caused 221 houses to be regarded as places of infection; 215 of them entirely escaped in the second. As for the remaining six houses, two of them were regarded as places of infection in the second outbreak only; in the first they had merely harboured persons who were thought to have received the infection elsewhere, so that four houses only were regarded as places of infection in both outbreaks. This seems to me a proportion so small as to be without significance, since re-invasion of the same area was almost certain to lead to re-invasion of some houses within it and it might have been expected *a priori*, of a much larger proportion than four. Then again it was found that the simplest operations of the scavenger cleared the infection away from houses as well as from districts once for all. Mere sweeping up and destruction of accumulated rubbish, the pulling down of a few ruinous outhouses, and a general cleansing of alley-ways and basements sufficed, without any disinfection properly so called. The more exact evidence on this head is drawn from examination of the isolated areas already referred to on which independent sub-epidemics had occurred; the uniform and (now) lengthy after-history sufficiently proves the point. They were liable to re-invasion of course, but it happens that plague has not reappeared on any of them. In short, the infection of plague does not inhere in places. Nor is there more than a remote analogy between the infectiveness of malarial places, and the infectiveness of plague-places, which latter is no sooner recognised than it may be summarily removed, and to which the disease in man is as nothing.

16. By these observations attention was forcibly redirected to the rat as cause, for they were at all events most completely explicable on the supposition that the infection was diffused by some animal which was free to wander among the dwellings of man, but which had access to the interior of only some of them. The kind of animal concerned was fixed, rather than indicated, by this hypothesis itself, because there is but one kind which lives in close association with man and at the same time is subject to plague. Many other kinds can be inoculated with this disease, and a few have been seen to contract it naturally; but the available evidence shows that they have always suffered secondarily, and that epizoötic plague has never begun among them. Hence it must be inferred, also, that plague is a disease which is proper to the rat. Another consideration seemed to be worth some attention although, doubtless, of a less cogent character; namely, while it is well known that the infection can survive outside the animal body for long under experimental conditions, it had practically never been identified outside it in nature notwithstanding the persevering efforts of many competent investigators. It remained, therefore, to endeavour by a special effort to establish some closer association between plague-rats and cases, or else to show that in reality such association existed but rarely and as an accident without signification for man.

17.

17. By following the direction thus pointed out, I found that the required close association between plague-rats and man did exist in every one of the small number of cases which constituted the outbreak of a later year (12). There were but twelve cases, spread over the seven months March to September; they occurred in nine buildings. In the small central area, where the epizoötic had begun before the first case occurred, seven of the buildings stood, yet well, or even widely, separated from each other; the other two were situated at long distances from it, the one 6 miles towards the south, the other 10 miles towards the north. In the two last-mentioned neighbourhoods no plague nor any suspicion of infection had ever existed; and the only feature by which they were distinguished from the rest of the metropolitan district (save the central area) was the ascertained presence of plague-rats and of cases in the two buildings. So also the central area was distinguished from the rest of the metropolitan district (save the two distant neighbourhoods) solely by the presence of plague-rats and cases in man in the 7 buildings, and of plague-rats unaccompanied by cases at other parts of it. The link by which these three widely-separated neighbourhoods were thus connected was also definitely discovered. Materials which experience has shown to be especially dangerous in connection with the introduction of plague into clean places, namely, hay, chaff, and corn in the one case, and gunny-bags and similar wastes to be used in paper-making in the other, had been conveyed to the two houses from premises on the central area which were ascertained to be infected with plague in their rats. This instance should not be undervalued because the number of cases to which it relates is small. In epidemiological investigations accuracy and completeness are the essentials; large numbers introduce confusion and soon render the method impracticable. As it was, the time and labour entailed by quasi-detective inquiries into the circumstances of the patients at home, at work, and at leisure, into those of the businesses with which they were connected, into the state of the rats on premises occupied or frequented by them, into the state of the neighbourhood of the premises as to rat-infection and as to freedom from it, and the establishment of dates by documentary evidence whenever possible, from time to time unduly taxed the attention of a staff not exclusively devoted to the investigation of plague.

18. The next point to which I would draw attention is the fact that epizoötic plague is likely to be often overlooked. The most important of the obstacles to its easy recognition lies in its character; there are others which attach merely to the search-conditions. As regards its character, there is a prevalent idea that the disease is so easily and so rapidly communicated from rat to rat that large numbers must always suffer together, and that in its final stages it usually causes rats to leave the nests to which they have retired at its onset, in accordance with the habit of sick animals, so that they die in the open; and thus, between the two, it is thought the presence of the epizoötic cannot escape even the common observer. Both of these features have been noted, but often they are wanting, and oftener still they are indistinct. This appears not merely from my own experience, but from consideration of the evidence indirectly furnished by accounts of rat-plague in many other parts of the world in which the point is not discussed. I give my own precise evidence immediately below; but before proceeding to recount it, I venture an opinion that the very slow rate at which recognition of the rat as the essential cause of epidemic plague has improved is due, in part at least, to prevalence of this idea and to consequently inadequate searches. If, on the one hand, observed coincidences between plague in rat and in man on the same areas have accumulated in noteworthy proportions since 1894, and if during the last five or six years increased importance has gradually come to be assigned to the rat, on the other hand it must not be forgotten that occasional admissions of its active agency have been limited, that the infectivity of man and of the rat have lately been spoken of officially (13) almost as though they had equal importance, and that formal statements have from time to time to time been made that epidemic plague can occur in absence of rat-plague. The vague and unsatisfactory character of these latter seems to have escaped notice. I will not delay to examine them, and will only observe that sometimes they are unsupported by any evidence (14), sometimes they are supported by evidence which cannot but be regarded as inadequate (15) by all who have had practical experience of the difficulties with which demonstration of rat-plague is so often surrounded, and sometimes they have been supported by references to documents which are seen not to have the meaning ascribed to them (16, 17, 18,) as soon as the originals have been consulted.

19. As a rule, plague among rats in any district is so far from possessing a devastating character that its progress is slow, long-drawn out, and even insidious. The disease picks out individual rats, affects a minority of the horde at any one time, and exhibits its activity only in comparatively small, circumscribed areas which are successively attacked. On individual premises I have occasionally found almost the whole colony dead; but this has been exceptional, and even there the rule has been that few plague-rats and many more healthy rats have been collected during many consecutive weeks. I have already published several examples (19, 20) of this, which left little doubt of the fact; but the evidence was not perfectly good since it was impossible (save in one of those examples) strictly to exclude repeated invasions from the generally infected neighbourhood. Nevertheless, I can show from the cases of two ships that it was probably entitled to its *primâ facie* value; and the chronicity of epizoötic plague (not as disease, but as epizoötic) seems to me a circumstance of so much importance in relation to plans for the prevention of plague, that I shall describe them at some length.

20. The first example (21) is that of the troopship "Antillean," which sailed from Capetown on 1st February, 1901, after having lain repeatedly alongside in the docks at South Arm. She first touched at Albany, Western Australia, where plague has never existed, lay there in the stream for about forty-eight hours from 20th February, and sailed again for Sydney direct after having taken in a little coal. On 22nd February cleansing of the holds was begun preparatory to arrival and the reception of troops, and during these operations about fifteen carcases of rats were discovered and cast overboard; no definite statement as to their condition was got, but they were not dried up. She arrived at Sydney 2nd March, and reported one deck-hand sick; his case was clinically plague, the disease was identified by morphological, cultural, and inoculation tests, and he died on the fifth day of illness. The rats on board were destroyed by sulphur fumes and, as the vessel was in ballast, no difficulty was found in completely gathering their carcases; the total number was less than 100. The great majority were free from disease; more than two, but very few, were infected. In one of the two plague was identified by morphological, cultural, and inoculation tests, and was ascertained to be present in the other by morphological and cultural tests. At Capetown (22, 23), history of unusual mortality among the dock rats reaches back to middle of December, 1900, and the first identified plague-rat was collected there on 4th February, 1901. On 27th February, 1901, occurred the first case of the epidemic which, as is well-known, comprised 766 cases; but inquiry revealed (in all probability) two earlier cases, of which the first dated back to 24th January. It may be taken, therefore, that the infection present on board on 2nd March may have been active since a short time before 1st February, when the vessel sailed, but had certainly begun to take effect before 22nd February; yet a majority of the few rats carried were in good health, and this notwithstanding that the single store-room must have been a centre of attraction for all the rats.

21. The second case (24) is that of the barque "Alsterschwann," 2,500 tons, which left Buenos Aires 17th May, 1903, after having shipped a full cargo of maize in bags at Rosario, and which arrived at Sydney direct 29th July. When this vessel got alongside, many carcases were found beneath the hatches; but as the latter had been specially closed tightly with some idea of saving the cargo from deterioration, it was supposed by the master that these rats had been stifled.

Nevertheless, the occurrence came to notice, and it was learned that 112 carcases had been gathered and disposed of. The result of the search then carried out was collection of fifty-one rats and carcases of rats, all of which turned out to be healthy except two, in which plague was identified by morphological, cultural, and inoculation tests. Then, after a first fumigation with sulphurous-sulphuric fumes, a further and larger number of carcases were collected and examined, among which, however, plague was identified in nine only. This search was necessarily more or less superficial, for the cargo was still in the holds, but after a second fumigation the barque was taken alongside, and unloading allowed to begin; a great many more comparatively fresh carcases were afterwards turned out, but the fact of plague infection having been fully established already, further examinations were not made. Plague first appeared at Rosario (25) in September, 1899. The infection must have been carried aboard the barque during seventy-four days, notwithstanding which a large majority of the rats which were examined were still free from plague.

22. General experience ashore, as distinguished from that derived from particular premises, was to the same effect. Thus the length of the epizoötic periods in each of the four years 1903–1906, reckoned from the first day to the last day on which a plague rodent was identified, was 14, 40, 47, and 49 weeks respectively. The total number of rodents examined during each of these terms was 14,671, 43,822, 28,446, and 27,731. Although there were exceptions, they may be regarded as having been all taken on the same small area of the city, and they were collected by the rat-intelligence staff in a regular way, the numbers brought in week by week having been approximately uniform. All of them were examined in the laboratories, and plague was identified in 161, 243, 141, and 174 of them. Some of these identifications were recorded almost in each week of each of the four terms; although there were some longer intervals, they occurred quite irregularly. The small proportion of plague-rats attracts attention, and is due in part to the account having been restricted to those carcases in which the disease could be bacteriologically recognised. Other carcases were submitted which were too far advanced in putrefaction for that kind of examination, some of which may be presumed to have resulted from plague; but their number was not large, and if reckoned, would not materially disturb the proportions mentioned, and would not at all disturb the time relations.

23. This evidence shows, I think, that epizoötic plague may pursue a chronic course, and that its long continuance may not be attended at any stage by such a mortality as could not be easily overlooked. Indeed, the figures just quoted show that there is difficulty in proving that any of the epizoötics referred to did much damage to the rat-tribe as a whole. But this difficulty owns two causes at least. As the putrefying bodies of plague-rats are not a cause of nuisance much more often than are those of the rats which die from day to day in the natural course, I suppose most of them die in the nests to which they have retired on first falling ill. The other cause is the conditions which prevent dwellings and warehouses from being thoroughly searched, unless the sanitary staff has taken possession of them; privacy and the course of business cannot be so hampered without substantial reason. However, when whole blocks of houses have been taken in hand and systematically cleansed, no remarkable number of rats ever has been turned out. When that course has not been taken, then the difficulties in the way of securing plague-rats, save in small number, have lain in the fact that only healthy rats, active in their search for food, are likely to be, and as a rule are, trapped; yet trapping is the only means available to an intelligence staff, for systematic poisoning no more leads to discovery of carcases than does plague itself.

24. Under all these circumstances, it will be perceived, rat-plague might easily be overlooked in places where the search cannot be, or is not, systematically and thoroughly carried out, and I have no doubt that it has occasionally escaped detection in this or that isolated area at Sydney, where the contrary was the case. It will also be judged, probably, that elaborate rat diagrams are not worth the labour of planning, for the figures on which they are based are necessarily incomplete, and largely result from incalculable chances by which even their relative value is vitiated. The fact is that the whole truth concerning epizoötic plague cannot be learned, and he who should accept the greater or less number of carcases observed in circumscribed districts as indicating greater or less need for energetic measures would often be deceived. The best search can at most only enable the limits of the area over which the epizoötic has extended to be defined, but that it can do with considerable accuracy. From all this a very important practical rule derives, namely: Discovery of a single infected carcase should be taken as peremptorily indicating the most thorough scavenging and cleansing of the neighbourhood in which it was found. Rarely will the labour entailed have been spent in vain. The case is quite different with an imported case in man; that, as we have already seen, calls for no action in respect of the neighbourhood.

25. Here a note on the species of *Mus* met with at Sydney, on their susceptibility to plague under natural conditions, and on the observed association of the different species with plague in man, may be usefully inserted. The species are *M. decumanus*, *M. rattus*, together with its Alexandrine variety which it is unnecessary further to mention separately, and *M. musculus*. These comprise all which have become domesticated. Plague has been identified in all of them, and in such numbers as shows, I think, that the proportions of each species enumerated in any year depended rather on local distribution than on any difference in susceptibility. In the first year to which I now refer, plague was identified in 86 D., 26 R., and 49 M.; in the second, 106 D., 73 R., and 62 M.; in the third (26), in 78 D., 45 R., and 18 M.; in the fourth (27), in 46 D., 89 R., and 39 M. I have found each of the two species of rats infected and associated with plague in man by itself, as well as the two together on the same premises. Infected mice have never been found alone in that association, so that I have nothing which points to the mouse as an efficient cause of plague in man; on the other hand, I have not observations sufficiently extensive to show that it does not so act. In a short series of nine houses, infected *M. musculus* was once actually found alone in association with one case of plague, but rats had at the same time died in number on the premises, although none were secured in a state which admitted of identification of the infection; *M. decumanus* was associated alone in a second, *M. musculus* and *M. decumanus* together in a third, all three species together in a fourth and fifth, and *M. musculus* with *rattus* in the remaining four. All the rats on the troopship "Antillean" (see above), on which was one case of plague at arrival, while another (to which it was unnecessary to refer before) occurred in connection with cleansing of the store-room, were *decumanus*. All those found on the other vessel, the "Alsterschwann," were *rattus* in its Alexandrine variety; in that instance no one was infected, either among the crew or among the many persons engaged in unloading and in disinfecting her. In a rural district, 300 miles from Sydney, where twelve cases occurred in ten houses, all the rats (1,128) taken, whether in the houses or in farm-buildings or on river banks, were *decumanus* with three exceptions; all the infected rats (101) were of that species, and there were two infected mice. At an important seaport 70 miles to the north of Sydney, where an outbreak consisting in fourteen cases occurred, plague was identified in 206 rodents out of 6,653 examined; 171 were *decumanus*, 13 were *rattus*, and there were 22 mice. The association of the infected species with plague in man at this place in the eleven cases which could be so examined was *decumanus* alone eight times, *decumanus* and *musculus* together twice, and *decumanus*, *rattus*, and *musculus* together once. The species found in connection with two large warehouses at Sydney where eight cases occurred was *rattus*; all the patients recovered. That connected with six cases which occurred at a small hotel was also *rattus*, and two of these patients died. The records might be further examined with quite similar results, but perhaps enough has now been said. After having

mentioned the caution that the following opinion does not result from complete knowledge, but only from what happened to be discovered, I may point out that the experience appears to indicate *M. decumanus* as rather the more susceptible, and practically rather the more dangerous. At all events, the suggestion recently made that in this relation *M. rattus* is the species to be feared, and that *M. decumanus* is, or perhaps may be, harmless, would fatally influence preventive operations at Sydney if it were adopted, and if it were possible to so conduct the destruction of rats as to spare the *decumanus* species on the ground that it would eventually destroy *rattus*. Doubtless there are variations in the susceptibility of the two species, and of each species in different countries or even in different parts of the same country; but I incline to think that the proportions observed to be infected depend primarily on local distribution.

26. If the evidence in general which has been adduced be now reviewed, I think it will be admitted that it goe very far towards proving that epidemic dissemination of the infection is effected by the rat alone. But it does not in any way explain communication of the infection from the rat to man. The evidence that the dead plague-rat is commonly harmless to man, though opposed by it, is not rebutted. The observation that association with plague-rats is most often without consequences to man remains unshaken, as also does the more important observation which teaches that when association has been accompanied by infection of man, much the most often only one person has been infected out of the whole of the exposed party. This led me from the first to suppose that solution of the epidemiological problem lay entirely with the manner in which the infection is communicated to man (28).

27. Practically the ways in which man may take the infection, that is to say, the ways which may so frequently come into operation as to cause epidemic prevalences, are but two; namely, inoculation and feeding. The pathological evidence thus far relied upon to establish infection through the digestive tract in reality merely shows that the disease often involves that part of the body. It does not show that it has entered the body by that route. Quite recently, however, the variable success attendant on feeding experiments with animals has been made the subject of a special investigation (29) conducted on the assumption that the virus is liable to be destroyed by contact with the acid contents of the stomach (as in cholera), and that greater certainty might be attained were it protected during its passage through that organ so as to be released in the ileum, where it would be exposed only to alkaline liquids. This hypothesis, it is said, has been justified by the results of feeding animals with small infected masses so dried externally as to resist peptic digestion. On the value of these results I am incompetent to offer any opinion. But I may draw attention to the practical considerations which prevent me from seeing how this mode of infection could operate in man, save exceptionally. The requirement is that the virus shall be discharged by rats (or by man) in small masses of the secretions of the body such that they may dry externally so as to form a protective envelope to the virus in the interior parts; and in these experiments the drying took from twenty-four to forty-eight hours, even over sulphuric acid. Discharge in the required form no doubt can happen. But the essential drying, I think, could not be brought about under natural conditions so as to produce infection of man, because his food either is moist itself so that the drying would be prolonged, and putrescible so that it must be speedily eaten; or it is moist though not putrescible and cannot be eaten (or at all events is not eaten) after the drying which a few hours brings about (bread); or it is dry, but too uncommon an article of diet to enter into a general cause (biscuits); or, lastly, it is dry, but incapable of being eaten until cooked (potatoes, grain). As between rat and rat the last-mentioned objection does not hold, and if the experiments referred to should be successfully repeated by others, it would then appear that rat-infection may occur in this way; however I am not now considering that point, but the mode of communication between rat and man. Certainly the infection of man is not commonly brought about by feeding, and it seems to me that this conclusion rests securely on the general pathology of the disease.

28. The same pathological evidence strongly supports the more generally received opinion that the infection is taken by man by inoculation. Indirect evidence is furnished by the observation that the frequency with which buboes appear in this or that region of the body is closely proportionate to extent of the drainage-area from which the lymph which is filtered in the glands of those regions has been drawn (30). The bubo is the characteristic lesion of plague, and is seen in all those cases in which resistance to the infection has been sufficiently strong. Its absence merely shows that resistance was defective, either absolutely or in relation to the dose or to the strain of the inoculated virus; and when the bubo does not form, then primary septicæmic or primary pneumonic plague results. The bubo appears where the assault on the body was first delivered and was most strenuously resisted, and it is distinguishable from the general glandular enlargements which later occur in every part of the body by the vastly greater damage done to the gland. All the lymphatic glands ultimately exhibit some rosy tumefaction; but one, or rather often two or three adjacent and immediately connected glands, alone show evidence of the violent struggle just mentioned in hæmorrhage, necrosis, and periadenitic effusions, and they alone indicate the area of skin into which the virus was inoculated.

29. Inoculation into the skin might be effected in two ways. The virus may be deposited by rat or by man on inanimate objects with which the skin of healthy man may come into contact. Such conjunction is not sufficient to infect, as is seen from the impunity with which *post-mortem* examinations are habitually made, unless the skin happens to be wounded. The uninjured skin is an efficient defence against infection by casual contact with the virus. These considerations have long been entertained, and originally it was thought that the preponderance of groin buboes among unshod people resulted from absorption of the infection through the wounds commonly present on undefended feet. But at a very early stage comparison between shod whites and unshod natives exposed on the same area showed that groin buboes preponderated among the former just as they did among the latter. So in 1900, I observed that out of 286 habitually shod persons who exhibited buboes no less than 73 per cent. had them in the groin (31). Casual inoculation through pre-existing wounds of the skin of the lower extremity is not the reason, then, why buboes are most commonly found in the groin. Nevertheless, probably infection could take place by that means; but difficulty in accepting this as the common explanation arises, as usual, in direct observation. Wounds of a competent character are rarely exhibited, and when the patient can account for them I have often found either that they were received after the probable date of infection, or so long before it that the trivial abrasion must have healed at a date prior to that of infection sufficiently to prevent entrance of the virus by it. Recognition of this mode of infection as the common mode rests entirely on theoretical grounds. Minor abrasions heal sufficiently to repair defences in twenty-four hours; and on reflection it will be perceived that rats can deposit the virus only on few and scattered spots, and that the chances against apposition between them and that small part of the body which carries some slight abrasion before lapse of the brief time within which the latter becomes repaired, must be incalculably great.

30. In 1902 I proceeded to inquire into the way in which man came to be inoculated in the course of daily life by the same method as had yielded the results already described in connection with other points, and to seek in the field some explanation of the fact that such inoculation takes place in the lower extremity more frequently than elsewhere (32, 33). First, I found that 106 out of the 139 cases of that year exhibited buboes in the groin. But as buboes in the femoral chain alone are evidence of inoculation in some part of the lower extremity, forty-six cases in which they were

situated in the inguinal chain had to be thrown out; sixty remained. But the majority of these sixty were for various reasons not available for my purpose. Thus, in sixteen of them either the place at which they were infected could not be determined, or the evidence for infection at home and at work was equally cogent, while in twenty-five others it was considered that the infection had been received at home, where, consequently, the patients had been exposed at bedtime to the risk (if any) attaching to bare feet which it was necessary to exclude. In four others the general history of the patients was defective; and in still three others, although infection probably did take place at work, the evidence was considered to be not quite unimpeachable. The result of this rigid sifting was rejection of forty-eight of the sixty cases, so that ultimately twelve remained in which *solitary* buboes situated in the *femoral* chain were exhibited by persons whose movements had been ascertained with certainty, and who beyond reasonable doubt were infected while at work. At their work-places they were all fully clothed. But their skins were not completely protected by their clothes. Their hands and arms, their faces, necks, and (as the weather was hot) often their chests too, were exposed; only their lower extremities were invariably protected by boots, socks, and trousers or petticoats. Yet they were inoculated not in their exposed parts, but in their protected parts. The deduction was almost obvious, and quite unavoidable. Inoculation must have been effected by some agent to which neither clothes nor the epithelium offered insurmountable obstacles; by some agent which could evade the one, and which could penetrate the other without causing either noticable pain or a visible wound. The flea alone answered these requirements. Moreover, within buildings fleas live in the dust between flooring-boards and in corners, outside them in the soil, and notoriously reach the legs first in places where they abound.

31. When these observations were first published (1903) there was very little experimental evidence that the flea possessed even the power of communicating plague between animals. It was limited to Simond's successful attempts in two experiments out of four made with an undetermined species of flea (1898), and the five successful experiments reported five years later by Raybaud et Gauthier (34, 35), which were made with the species *Ceratophyllus fasciatus*. Against these rare successes were to be set the greatly larger number of failures reported by several competent observers, and from my own laboratory. Since then, possession of this power by the species *Pulex cheopis* (Rothschild) has been placed beyond dispute by the First Report of the Plague Research Committee which was appointed as the outcome of representations made by the Lister Institute to the Secretary of State for India in 1905, and which is still working in Indiaunder direction of Dr. Charles J. Martin, F.R.S., Director of the Lister Institute (36). It may be expected that in its next report the Committee will be able to define the conditions under which this power is exercised, both in relation to species of fleas and to mechanism. Probably all fleas share it on condition that they are of kinds which infest rats and sometimes attack man. This is the more likely that the position of the bacillus among the schizomycetes seems to connote a merely mechanical transference of the infection by the flea (37); but on the other hand my field-observations seem to me to require duration of the power to infect over considerable, and even over rather long periods (38). In conclusion on this head I would point out that although the experimental demonstration thus furnished is essential, and may be accepted as affording ground for inferring that the virus can also be conveyed by the same means from lower animals to man, yet the importance of this mode of infection as a factor in production of epidemic plague can be established only by observation in the field of daily life. I conclude from the investigations which have just been described above that while plague may be casually acquired by man in several ways, the flea is the ordinary agent of his infection, and it as well as the rat is indispensable to produce epidemicity.

32. Thus the lines which must be followed in efforts to prevent or to check plague are very clearly indicated. It is not possible to discuss this subject in detail within the limits assigned on the present occasion, but a few leading points can be mentioned.

33. In the first place, notwithstanding that plague is not *maintained* by communication of the infection from the sick, yet it is communicable from them and occasionally is seen to be so communicated. Further, although such communication from them as occasionally takes place cannot by itself give rise to epidemics, the following consideration is entitled to weight, namely: Since plague can be and generally is communicated from rat to man by the flea, so it must be possible for it to be communicated from man to the rat, an accident which might bring about an epidemic But the frequency with which this risk will be encountered depends first on parasitic infestation of the patient; secondly, on his proximity to rats; and thirdly, on his disease having reached the septicæmic stage. These are chances which must weigh importantly in all countries against communication of the infection from man to rat, although in some they may have less influence than in others. Plague in the rat is almost always a septicæmic disease, but in man the primary septicæmic form occurs much less often than the bubonic; yet any bubonic case may become septicæmic shortly before death, and many do so. My own experience has furnished little which pointed to transference of the infection from the sick even to man when the circumstances have been fully discovered. In some cases which at first seemed doubtful, inquiry ultimately established presence of plague-rats, or in a few in which nothing explanatory of the infection could be found, the evidence as a whole was so defective that they had to be set aside as merely undetermined; but in three or four probably the infection was so communicated. In some countries, as, for instance, India, a contrary experience may perhaps be common, and in course of time may be shown to be so on tangible evidence; still, India, is a country where association between people and rats seems to be much closer and more nearly universal than elsewhere. However that may be, I would express the opinion that every case of plague should be segregated, and I note that every case has always been and still is segregated at Sydney within a few hours of notification. Never have I had reason even to suspect that the infection had been communicated from man to rat.

34. Secondly, it would seem that preventive measures should be directed, not only against the rat, but against the flea, and this course has been advocated. I think it evident that it cannot be taken with hope of practical success, save in special circumstances. They are these: When plague-rats have been found in a dwelling or other building which is about to be cleansed, the first thing to be done is to spray the floors very freely with a 5 p.c. solution of coarse carbolic acid, or an equivalent solution containing mixtures of the tar acids. This is a very effectual method of driving away and of killing fleas, and thus of avoiding the only risk connected with the cleansing of plague-infected premises. The residuum left from the distillation of kerosene is also efficacious for this purpose; but it is a stinking and oily substance, of which the use is limited by those qualities. For the rest, it seems to me that effort to destroy fleas, which cannot be successful, must divert attention from the rat, or at least divide it. Now the flea derives its importance from the rat; and although it wanders to some distance after its host has died, still the direct attack should be upon the rat. The rat is the *fons et origo* of the infection for man.

35. Rat destruction is a subject on which a great deal might be said. Extermination of the rat is impossible with any means thus far made available. Perhaps larger numbers have been destroyed during several years at Tokyo (39) than anywhere else, and yet it was hardly possible to recognise any impression made on the rat-tribe as a whole. My own experience has been similar; but from time to time diminution in the numbers present in circumscribed districts has been

produced by energetic poisoning and trapping. This has importance in relation to the limited areas over which the epizoötic extends at any one time. But although occasions will arise from time to time on which effort may be directed to destruction of rats known to be present, as a rule infected neighbourhoods must be dealt with in a more general way, by scavenging and destruction of accumulations or places in which rats have found, or probably may find, harbourage, and especially by storing food and food-wastes so that rats cannot reach them. These operations should be guided not by rats seen, or even traced, but by the conviction otherwise acquired, that rats must be present, seen or not seen, wherever man has been infected, and can be driven out. Unless rat-staffs are firmly impressed with that belief, such operations will seldom be thoroughly successful.

36. Lastly, the difficulty in arresting rat-plague is, in my local experience, in direct ratio to the bad construction of wharves, quays, and the buildings upon and near them. The danger to man from plague is everywhere directly proportionate to the accessibility of the interior of buildings to rats, although it is not quite absent outside them. When the difficulty of staying the infection by action directed to the rat is considered, and, above all, the impossibility of staying it within so short a period of time as shall effectually avoid the danger to man, I think it will be perceived that the rational method of defence lies in so improving the construction of buildings as greatly to impede the entrance of rats to them, and in so taking care of food that it shall not attract them.

37. In a broad view, then, all other measures must be considered as subsidiary to re-construction of ill-built wharves, stores, and warehouses, and to such repair and special fitting of inhabited houses as will keep rats outside them. It is easy to convince the intelligent laity that this advice is based on sound reasons; but unfortunately it is very difficult to satisfy them that the considerable expenditure it connotes will yield an appreciable profit to the community, and an efficient protection to individuals against losses which sometimes are almost ruinous.

Sydney, 28th April, 1907.

J. ASHBURTON THOMPSON.

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REFERENCES.

1. Primet (1901). Rapport sommaire sur l'épidémie de peste qui a régné en Nouvelle Calédonie du 23 Decembre 1899 au 9 Mars 1900. Ann. d'Hyg. et de Méd. Col., p. 258.
2. Robinson, Sir William, G.C.M.G. (20th June, 1894). Despatch from the Governor of Hongkong to the Secretary of State.
3. Lowson, James A. (1st March, 1895). The epidemic of bubonic plague in Hongkong, 1894. Government Printers.
4. Condon, J. K., Captain, Indian Staff Corps (1900). A history of the progress of plague in the Bombay Presidency, from September, 1896, to June, 1899; compiled by order of Government. Education Society's Steam-press, Bombay.
5. Lorans, H. Acting Principal Medical Officer (26th April, 1900). Report on the outbreak of plague in Mauritius. Government Printer, Port Louis.
6. Hankin, E. H. (1898). La propagation de la peste. Ann. de l'Inst. Pasteur, tom. XII, p. 785.
7. Simond, P. L. (1898). La propagation de la peste. Ibidem, p. 625.
8. Thompson, J. Ashburton (13th November, 1900). Report on an outbreak of Plague at Sydney, 1900. Government Printer.
9. Thompson, J. Ashburton (31st July, 1903). Report on a second outbreak of plague at Sydney, 1902. Government Printer.
10. Conférence Sanitaire Internationale de Paris, 1903. Procès verbaux des Séances de la Sous-commission Technique, p. 354.
11. Yersin (1894). La peste bubonique à Hongkong. Ann. de l'Inst. Pasteur, tom. VII. p. 662.
12. Thompson, J. Ashburton (7th July, 1905). Report on a fourth outbreak of plague at Sydney, 1904. Government Printer.
13. India, Resolution of Government (17th January, 1906). Calcutta.
14. Calmette (1903). Paris Conference, ut supra, p. 356.
15. India, Report of the English Plague Commission in (26th July, 1901). Par. 272.
16. Thomson, Theodore (1904). Memorandum on rats and ship-borne plague. Supplement to 33rd Annual Report, Local Government Board. London 1905, p. 324.
17. Chalmers, A. K. (August, 1901). Report on certain cases of plague occurring in Glasgow in 1900 by the Medical Officer of Health; p. 86.
18. Hope, E. W. (1902). Report on the health of the city of Liverpool during 1901 by the Medical Officer of Health; p, 169.
19. Thompson, J. Ashburton (7th December, 1904). Report on a third outbreak of plague at Sydney, 1903.
20. Thompson, J. Ashburton (October, 1906). On the epidemiology of plague. Journ. of Hyg., VI., pp 552-3.
21. Report Sydney, ut supra, pars. 50 to 65.
22. Gregory, A. John (21st May, 1900). Report of the Medical Officer of Health on the public health for the year 1903. Government Printer, Capetown.
23. Gregory A. John. Report of the Cape Peninsula Plague Advisory Board (1901), pp. 5–10. Government Printer, Capetown.
24. Report, Sydney, 1903, ut supra, par. 24.
25. Memoria del Departamento Naçional de Higiene. A. S. E. el Sr. Ministro del Interior (Julio 15 de 1900), p. 27. Buenos Aires, 1900.
26. Thompson, J. Ashburton (12th July, 1906). Report on a fifth outbreak of plague at Sydney, 1905. Government Printer.
27. Thompson, J. Ashburton (21st January, 1907). Report on a sixth outbreak of plague at Sydney, 1906. Government Printer.
28. Report, Sydney, 1900, ut supra, pp. 29 and 36.
29. Klein, E. (1906). Studies in the Bacteriology and Ætiology of Oriental Plague, p. 157, et seq.
30. India, Report of the English Plague Commission in, par. 175.
31. Report, Sydney, 1900, ut supra, p. 40.
32. Report, Sydney, 1902, ut supra, pars. 262-70.
33. The Lancet, 1903, vol. 2, p. 1090.
34. Raybaud et Gauthier (December, 1902). Comptes rendues de la société de Biologe, tom, LIV. p. 1497. Paris.
35. Raybaud et Gauthier (May, 1903). La. Rev. d'Hyg., tom. XXV, p. 426.
36. Journal of Hygiene, vol. VI, 1906.
37. Thompson, J. Ashburton (June, 1906). Address on the Epidemiology of Plague, part VI, par. 3. Transactions of the Congress of the American Medical Association, Boston.
38. Report, Sydney, 1902, ut supra, par. 300.
39. Kitasato, Shibasaburo (3rd March, 1906). Combating plague in Japan. The Philippine Journal of Science, vol. I, No. 5, p. 465.

[Four Diagrams.]

Sydney: William Applegate Gullick, Government Printer.—1908.

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